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No. 3

ELECTROCAUTERIZATION IN THE TREATMENT OF HUMAN BITES*

BY WILLIAM BATES, M.D.

OF PHILADELPHIA, PA.

IN THIS study of human bites are grouped, not only bites originating as bites, but also wounds in the region of knuckles caused by blows against the teeth in fighting. The mouth contains more dangerous organisms than any other portal of the body. A wound caused by a tooth is infected immediately with many organisms of varying degrees of virulence. In addition, the infection is planted on the fertile soil of crushed tissue.

In the absence of rabies, infection of the wound is not to be expected in dog bites. A dog bite may be mutilating, and thus dangerous to life, or it may cause actual rabies, but only rarely does it cause infection.

I have treated many dog bites without cauterization. The wounds are thoroughly cleansed and a simple antiseptic applied without fear of resulting infection, thus confirming the adage, "As clean as a hound's tooth."

The infection in animal bites in general is not as severe as in a human bite. A horse bite is more of a pinch than a bite and seldom breaks the skin. A cat bite produces a wound that soon shows severe infection. Such a wound is best treated as a human bite. If the skin is broken by either a horse or a cat bite, tetanus antitoxin should be administered.

In spite of the difference in bacteriology, and the progress of the resulting wounds, we originally attempted to treat the human bite the same as an animal bite, by phenol cauterization and the application of various antiseptics. Our results were bad.

Regardless of the type of treatment given at first, the proportion of human bite cases that became worse from day to day was entirely too great.

In going over the records of three dispensaries in which I have worked, I found in the past seven years that we have treated over two hundred cases of wounds infected from human teeth.

Various other forms of treatment advised in surgical literature gave equally unsatisfactory results. Papers have appeared occasionally in the form of case reports, three^{1, 2, 6} of these reporting the similarity of infecting organisms, but of no help in treatment. Some articles^{2, 3, 4} have detailed the bacteriologic studies in from one to six cases. The result of these studied cases has been to attribute the infection to the organisms of Vincent's angina. Another bacteriologic study⁵ of a bite showed "Only ordinary staphylococci, no streptococci nor other malignant organisms."

* Read before the Philadelphia Academy of Surgery, November 3, 1930.

Investigations by Hennessy³ and Peters⁴ have shown that when the *B. fusiformis* and its symbiotic spirochete recovered from their cases of human bites were injected into the peritoneal cavity of laboratory animals, they would not multiply and nothing happened; or at times, the injection produced only a very mild infection. The writers concluded that the trauma to the tissue by the teeth produced the factor necessary for reproduction and spread of the infection.

Bacteriologic reports in some of my own cases were taken before treatment was given. Unfortunately, I had no studies made at the time when we were seeing the late severely infected wounds. From these few reports, we learned that the *B. subtilis* was sometimes present, occasionally the streptococcus viridans was reported and usually the staphylococcus aureus and staphylococcus albus were present. In none of our cases studied from smear and culture taken prior to treatment did we find the organisms of Vincent's angina.

Prior to our instituting a change in therapy, the patients came to the dispensaries after a variety of first treatments, and in various stages of wound infection. As an example of first treatments, the figures from one accident ward in 1924 indicate—thirty-six cases were treated—one with incision and drainage, five with mercurochrome, fourteen with iodine, three with silver nitrate and thirteen with phenol and alcohol. The wounds soon showed evidence of foul infection. Usually they had a green sloughing edge, marked swelling about the point of injury, and a characteristic skatol-like odor. The patients complained bitterly of pain. Lymphangitis and lymphadenitis appeared shortly. It soon became necessary to give wide drainage, even in the cases in which incision and drainage were part of the first treatment.

Tendon slough and extension of infection up the tendon sheath were frequent. Often the whole hand became oedematous and later osteomyelitis of the phalanx or metacarpal developed. A bite wound penetrating to the phalanx frequently meant amputation of the finger. The dorsum of the hand, just proximal to the metacarpo-phalangeal joint is frequently pierced by a tooth in bare hand fighting. According to pugilistic style of the injured, these wounds are over the distal end of either the second or fifth metacarpal. Frequently the complete severance of the extensor tendon, and even fracture of the metacarpal results. Immediate tendon repair is contraindicated because of impending sloughing.

Delay in first treatment, or too great an interval between first and second treatment was frequently encountered. The original wound was often trivial and to the patient apparently unimportant. The delay in applying for treatment, or in some cases, a misleading history as to the cause of the wound, is commonly due to shame on the part of the patient. An attempt is sometimes made to cover up a fight and attribute the wound to an industrial accident. In one case, the patient attributed the wound to a dog bite. Pain finally draws them to the doctor for treatment. Yet, in all fairness to the patient, there was not enough difference between a neglected wound,

ELECTROCAUTERIZATION OF HUMAN BITES

and one apparently well-cared-for under the old forms of treatment, to attribute the spreading of the infection to neglect. The condition of the wound was dependent on the virulence of the infection and the amount of crushed tissue present. In the finger cases, the osteomyelitis usually developed so rapidly that amputation was the rule rather than the exception.

Thus far the discussion has been limited to bites which cause a penetrating wound. The avulsive bite and the amputating bite are of less severity from an infection standpoint. These cases present a large open wound, freely drained, and all crushed tissue is on the surface.

Certain of the incomplete avulsive bites leave a double row of penetrating tooth marks, mainly on cheek, nose, lip, deltoid region or calf of leg. These wounds become quite troublesome as there is much crushed tissue and frequently the area between the rows of teeth marks has been deprived of its blood supply.

Because of the bad results obtained with the older forms of treatment, I started, in 1925, to treat human bites with the electric cautery. The technic is simple, and the apparatus is available in every hospital. The patient is given a gas anæsthesia as soon as permission can be obtained. A cautery knife or a post-cautery blade is heated to a cherry red. In the penetrating bite cases, the whole tooth mark is removed with the cautery. There is practically no bleeding and the nerve ends are destroyed by the heat. The wound is dressed with a mild antiseptic. The patient awakes with a pain-free wound. Subsequent dressing consists of boric-acid ointment, or mercurochrome or other mild antiseptic applications. The scar produced is much less than one resulting from a scalpel excision of the same size. In the avulsive and amputating bites, the entire raw surface is seared with the cautery. In the massive bite where avulsion failed, the question of treating as double penetrating wounds, or as avulsion, arises. The decision depends on the amount of intervening tissue and the condition of the blood supply. If doubt exists, the avulsion is completed, and the whole new surface is seared. The best time to apply this treatment is immediately after the wound is produced.

It has been claimed on theoretic grounds that the cautery should not be used when the infection has spread so widely that complete removal of all infected tissue is impossible, because sealing off the lymphatics will prevent free drainage. However, I have used the cautery on the third or fourth day in numerous cases, in some of which all the infected tissue could not be removed. These cases have had very satisfactory results because of the immediate destruction of the primary focus, drainage quickly reestablished into the newly created open wound and the normal phagocytic action is capable of destroying the organisms in the surrounding lymphatics.

We have treated over one hundred cases of human bites by electrocauterization, and extension of infection thereafter occurred in only one case in which the extensor tendon of an index finger was severed, with a fracture of the distal end of the second metacarpal extending into the joint, during

WILLIAM BATES

a fist fight. In spite of cauterization on the second day, amputation of the index finger and part of the metacarpal became necessary. With the exception of that case just detailed, and one other who, at first, attributed his bite to a dog and therefore was not treated by electrocauterization, we have not had to admit any human bite cases to the hospital since 1925. This contrasts most favorably with the long hospitalization, and multiple operative procedures found prior to 1925. We have never computed the hospital days required per patient in our early cases but cases reported by other writers give figures from forty-five to fifty-four days.

Wound healing is frequently complete by the fourteenth, and almost always before the twentieth day, when the original treatment consists of electrocauterization.

The comfort of the patient and the economic saving, both to the patient and to the hospital, amply justify the simple procedure of electrocauterization of human bites.

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CIRCULATORY DISEASES OF THE LOWER EXTREMITIES

WITH SPECIAL REFERENCES TO TESTS OF CAPILLARY CIRCULATION*

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AND

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FROM THE SURGICAL SERVICE OF THE SAN DIEGO COUNTY HOSPITAL

CIRCULATORY imbalance between the arterial system of efferent vessels and the afferent vessels of the venous and lymphatic systems may produce a variety of symptoms. Clinically this is manifested by the cold, discolored leg of arteriosclerosis, the swollen and frequently ulcerated leg associated with varicose veins, and finally the brawny swelling of lymphœdema.

Pathologic changes in one or more of these systems may produce combined dysfunction. Lymphœdema, for example, often accompanies impairment in the venous return of an extremity as is seen in varicose veins or more especially thrombophlebitis. In this instance venous stasis is assigned the primary rôle, whereas in fact, obliteration of the lymphatic vessels is essentially responsible. That the integrity of the circulation is not interpreted to the clinical satisfaction of many is borne out by the numerous clinical methods advocated. A notable few are color changes in the extremity in different positions; testing the reaction time following partial and total occlusion of the femoral artery; observation of the hyperemic reaction after pressure, the recording of temperature in the extremity of tactile sense, thermometer, thermocouple and galvanometer; the use of the calorimeter of Stewart, the viscometer and the oscillometer of Panchon, blood-pressure estimations, röntgenograms following introduction into the vessels of opaque solutions and lastly the intracutaneous injection of saline and histamine acid phosphate with careful observation as to their characteristic reactions. It is with a comparison of the last-mentioned tests in a variety of circulatory disturbances that this paper particularly deals.

The Intradermal Salt Test.—Aldrich and McClure found that 0.2 cubic centimetres of an 0.85 per cent. solution injected into the skin of a normal individual required sixty minutes or more for complete absorption. In cases showing œdema or other evidences of circulatory insufficiency the disappearance time is decreased in direct ratio to the degree of œdema or anoxæmia produced by the vascular involvement.

Stearn has used this test in a number of vascular diseases of the lower extremities affirming that it is a simple, rapid and accurate method of determining circulatory deficiencies.

The Histamine Test.—Sir Thomas Lewis has shown that following the introduction of a minute amount of histamine into the skin there followed: First, local dilatation of capillaries, venules and arterioles by direct action (a purple spot); second, widespread dilatation of surrounding arterioles resulting from a local reflex (the flare); and third,

* Read before the Southern California Medical Association April 4 and 5, 1930.

local increased permeability of the wall of minute vessels by direct action (the wheal). Certain of his experiments show that, if the circulation is completely obstructed, neither wheal nor flare follows the introduction of histamine. Also if the skin is cooled by placing in water from 12° to 15° C., the development of wheals is much retarded, this being interpreted as the result of decreased blood-supply.

These experiments of Lewis suggested that the reaction might change similarly if pathologic change obstructed the circulation and so give useful evidence of diminished peripheral blood-flow and blood-pressure, especially in the extremities. One finds that in normal persons the reaction of the skin of the feet to histamine is prompt and complete; but in cases in which there is strong clinical evidence of deficient circulation the reaction is delayed, reduced or incomplete, and this may occur where the clinical examination is essentially negative.

Starr lists the abnormal reactions in relation to their importance as follows: (1) Delay in appearance of the reactions; (2) reduction in the intensity of the reaction; (3) failure of the flare or the wheal to appear, the site of puncture being marked only by the purple spot of capillary dilatation described by Lewis where the circulation was completely obstructed. If nothing appears at the site of puncture, an error in technic should be suspected.

The wheal is by far the most important part of the reaction. The flare is sometimes indefinite in outline and difficult to see, especially in anæmic patients.

Following his work on arteriosclerotic and diabetic patients, Starr concludes that the absence of histamine reactions means an arterial occlusion of some degree and advocated it as a test of circulation.

De Takats reports that of thirty patients with varicose veins, approximately 50 per cent. showed an abnormal reaction.

Analysis of Cases.—A total of eighty-nine cases was examined. This group included fifteen cases of normals in children, twelve cases of normals in adults, fifteen cases of varicose veins without ulceration, twenty cases of varicose ulcers, five cases of arteriosclerotic ulcers, five cases of traumatic ulcers, four cases of chronic ulceration following burns, two cases of luetic ulcers, two of diabetic ulcers, three cases of thrombophlebitis and six cases of œdema of the legs of cardiac origin.

The salt and histamine tests were performed on these extremities at levels of the ankle, mid-leg and mid-thigh.

For the convenience of comparison each was calculated on a percentage basis, so that the figures in accompanying charts represent percentage variations from normal. In the salt test 0.2 cubic centimetres of an 0.85 per cent. salt solution was injected with a hypodermic needle intracutaneously, a normal 100 per cent. reaction requiring sixty minutes or more for the absorption of the resulting wheal. For the histamine test a 1:1000 solution of histamine acid phosphate in physiologic solution of sodium chloride was applied with a medicine dropper to the skin and six or seven punctures with a fine hypodermic needle made. Observations were recorded at two-and-one-half-, five-, ten- and fifteen-minute intervals. A normal 100 per cent. response in this test was interpreted following the typical reaction (presence of both wheal and flare) in two and one-half minutes with its completion in five minutes. The greatest intensity was usually reached in from five to fifteen minutes.

CIRCULATORY DISEASES LOWER LIMBS

CHART IA

Normals—Children

Age.....	7	5	11	6	10	13	6	11m	8	4	4	4	12	8m	7
Diagnosis	Pyelitis	Pyelitis	Pneumonia	Pyelitis	Pneumonia	Leitic Adenopathy	Pyelitis	Malnutrition Dehydration	Otitis Media	T. B. Meningitis	Pyelitis	Burns, Back	Otitis Media	Malnutrition	Tonsils and Adenoids
No. of cases.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Thigh.....	90	60	90	70	80	100	90	40	80	60	70	90	60	100	70
Leg.....	90	60	90	70	80	100	90	40	80	60	70	90	60	100	70
Ankle.....	90	60	90	70	80	100	90	40	80	60	70	90	60	100	70
Histamine.....	100	70	50	90	100	100	75	90	80	45	60	50	80	80	50
Control.....	100	100	80	100	80	100	95	90	90	60	100	90	80	100	90

Note definitely low salt values in Cases 2, 4, 8, 10, 11, 13, and 15, with corresponding low histamine values in most instances. Also abnormally low histamine values in Cases 3, 7, 10, 12, and 15. The low salt value in Case 8 is obvious in association with the abnormal water balance. There is more variation in these cases than would be expected in such a group showing no circulatory disease.

CHART IB

Normals—Adults

Age.....	30	83	72	25	23	28	35	29	55	42	70	30
No. of cases.....	1	2	3	4	5	6	7	8	9	10	11	12
Thigh.....	80	60	90	90	100	100	70	80	90	80	90	80
Leg.....	80	65	90	95	100	100	60	80	90	80	90	70
Ankle.....	80	65	90	95	100	100	60	80	90	80	90	70
Histamine.....	90	80	90	80	100	100	60	60	75	70	95	85
Control.....	100	90	95	100	100	100	90	100	100	90	100	90

Feeling that the group of children tabulated was not a fair index of normal reaction, twelve normal adults of varying ages were examined. In this group we obtained less variation, although Cases 9, 10, and 12 could be classed as definitely border-line, while 2 has a low salt value, 7 is below normal with both the histamine and salt, and 8 has a definitely low histamine.

CHART II

Varicose Veins—No Ulcerations

No. of case.....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Thigh.....	70	80	85	90	80	60	90	60	80	70	60	90	60	80	90
Leg.....	70	70	70	90	80	60	90	50	80	70	60	90	70	70	85
Ankle.....	65	80	70	90	100	70	90	50	80	70	60	90	60	70	85
Histamine.....	65	90	70	60	60	70	60	45	70	70	65	60	70	70	60
Control.....	90	90	70	90	100	100	90	80	100	90	100	90	100	90	90

Note consistently low values in both tests in this group with greater uniformity in the histamine reaction.

CHART III

Varicose Ulcers

No. of case....	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Thigh.....	90	70	80	85	80	80	85	80	60	80	100	85	90	95	100	95	60	90	80	50
Leg.....	85	70	75	85	70	90	80	80	60	80	100	85	90	95	100	90	60	90	80	40
Ankle.....	85	70	50	85	65	90	80	80	60	80	90	70	90	80	100	90	60	90	80	40
Histamine.....	100	80	80	100	75	95	100	60	75	65	75	65	80	90	50	60	55	60	75	70
Control.....	100	90	90	100	100	95	100	100	70	100	100	100	90	95	100	100	90	95	100	90

HOLDER AND McDOUGALL

Note generally higher values of saline tests in this group. With several exceptions there are proportionally lower and more consistent histamine values as in Chart II.

CHART IV

No. of cases.....	Arteriosclerotic Ulcers					Traumatic Ulcers					Chronic Ulceration Following Burns			
	1	2	3	4	5	1	2	3	4	5	1	2	3	4
Thigh.....	80	60	80	95	70	80	80	90	80	60	80	60	70	80
Leg.....	80	60	75	95	70	80	70	90	80	50	60	60	70	70
Ankle.....	80	60	80	95	70	80	70	90	70	50	70	60	75	70
Histamine.....	100	90	50	75	100	80	80	80	75	60	50	60	45	80
Control.....	100	100	100	80	100	100	90	100	80	100	90	80	95	90

Due to the small number of cases in the arteriosclerotic group any pertinent deductions are not possible. Here the saline values run consistently lower while in three cases the histamine test was practically normal. In this instance we expected uniform low values with both tests.

Again in the traumatic group both tests were generally inconclusive, possibly the histamine reaction showing a more uniform downward trend.

In the chronic ulcerations following burns both tests showed consistently low values.

CHART V

No. of cases.....	Luetic Ulcers		Diabetic Ulcers		Phlebitis of Extremity			Cardiac Oedema of Leg					
	1	2	1	2	1	2	3	1	2	3	4	5	6
Thigh.....	90	70	45	50	90	70	80	10	15	35	20	30	20
Leg.....	90	70	45	50	90	70	80	10	15	30	20	30	15
Ankle.....	90	60	45	50	90	60	75	10	15	30	20	30	15
Histamine.....	100	80	60	70	90	100	60	75	50	90	85	90	80
Control.....	100	90	100	80	100	100	100	100	100	95	100	100	100

In the two cases of luetic ulcers no definite result was obtained except low salt values in one case.

In cases of diabetic ulcers both tests definitely recorded impaired circulation.

In thrombophlebitis one case showed a normal reaction to the salt test. Of the other two, one had a low salt value with a normal histamine, the other showing lowering of both, particularly the histamine.

The cases of cardiac oedema all showed very low values with the salt test. The histamine reaction was within normal variations in three instances and moderately lowered in two.

COMMENT

We have tried to reduce the margin of error in estimating these results to a minimum. Of necessity, individual judgment must enter into the valuation of each case. Results have been recorded without regard to preconceived opinions. With this admission of a possible source of error we feel there is a large degree of uncertain variation in these tests, with little correlation between the two.

A general impression in this particular group of cases with circulatory disease is that the histamine test, although bearing the above general criticism, gives a better index of possible circulatory insufficiency than the salt test.

DERANGEMENTS OF THE SEMILUNAR CARTILAGES

BASED ON A STUDY OF 388 OPERATIVE CASES

By W. RUSSELL MACAUSLAND, M.D.

OF BOSTON, MASSACHUSETTS

FROM THE MACAUSLAND ORTHOPEDIC CLINICS

IN AMERICAN medical literature there is a noticeable lack of contributions devoted to derangements of the semilunar cartilages. To be sure, the general field of internal derangements of the knee-joint, embracing pathology of the semilunar cartilages, fat-pads, synovial membrane, and the joint surfaces with their ligamentous structures, has been discussed in numerous articles, but the reports pertaining to the menisci have been comparatively few. This paucity of data gave me the incentive to compile the derangements that had been treated in our clinics. From 1910 until the present time the operative cases have numbered nearly 400. The purpose of this article is to present a study of derangements based upon this series of cases, and to correlate the clinical findings, the pathology, and the end-results.

In this study I have been greatly impressed with the frequent occurrence of errors in diagnosis and treatment of mild joint injuries. There seems to be a tendency on the part of many physicians to regard a slight damage to the meniscus as too trivial for treatment. As a result, the joint is left in a weakened condition, exposing it to the development of further symptoms that may become a potential danger to the function of the joint. In this paper, particular emphasis will be placed upon the recognition and treatment of mild injuries.

1. *Anatomical Considerations.*—The great strength of the knee-joint lies, not in its osseous structures, but in its supporting ligaments and muscles.

2. A relationship exists between the internal semilunar cartilage and the internal lateral ligament, a relationship that does not exist between the external semilunar cartilage and the external lateral ligament. Most anatomists are of the opinion that the external surface of the internal semilunar cartilage is firmly connected with the inner lateral ligament, making the two dependent upon each other in movement. Fisher¹ in his work found that only the posterior fibres of the ligament were firmly attached to the peripheral border of the semilunar cartilage, while the anterior part was loosely connected. Thus, a weak mechanical spot exists between the fixed and the mobile parts of the cartilage.

3. The internal semilunar cartilage is firmly attached along its entire border to the capsule.

4. The external semilunar cartilage is more mobile than the internal. There is no connection with the lateral ligament and it is less closely adherent to the articular capsule. Also, its attachments are more lax, and the cartilage moves as a whole.

5. A possible connection between injuries of the crucial ligaments and lesions of the semilunar cartilages is suggested by Galeazzi.³

6. Fisher¹ mentions the possibility of confusing an injury to the semilunar cartilage proper with a lesion of the semilunar extension of the infrapatellar fat-pad.

7. At the completion of the movement of extension, and at the beginning of flexion, some rotation takes place, a screw-like motion, which locks or unlocks the joint.

Etiology.—There are several factors that may predispose injury to the cartilage. An individual whose ligamentous and capsular structures are in a lax condition as the result of an occupational strain or synovial effusion is more susceptible to cartilage injury. (It is strange, however, that healthy persons whose ligaments and muscles are in perfect tone are affected more often.) Static disturbances due to flat or pronated feet, or due to knock-knee that leads to the stretching of the inner section of the capsule and the internal lateral ligament, are potential factors. Some individuals may have cartilages with weak attachments, or the muscles and tendons surrounding the joint may not be in good tone.

The immediate etiological factor in the majority of cases is trauma. When one considers that the knee-joint is relatively unprotected by soft parts, and when one considers that the joint acts as a fulcrum for the two longest levers of the body, it seems remarkable that injury is not more common. By far the greater number of derangements is due to indirect trauma, as might be expected in view of the tremendous strain upon the ligaments and articular surfaces, amounting, if calculated, to thousands of pounds. The most common type of injury is a wrench or inward twist of the femur when the knee is flexed, the leg abducted, and the foot in a fixed position. Such a movement is often made in dodging or running, or in rising suddenly from a squat position. Consequently, trauma is frequent among workers, and among athletes who engage in strenuous forms of exercise. In reports by British operators, attention is called to the frequency of the lesion among miners, who, in rising from the squat position to throw a shovelful of coal over the shoulder, may suddenly twist the thigh. In the case of miners, the loss of tone in the muscles and ligaments as the result of working in a stooped position is a predisposing factor. This prevalence of the lesion among miners has led to the use of the term "miners' disease." Martin,⁴ in a series of cartilage cases, noted the following distribution of injuries:

62.8 per cent.—miners

18.0 per cent.—football players

2.0 per cent.—athletes of some nature

In the series of cases which I am reporting, falls were responsible for the majority of the derangements. There was a high incidence among participants in sports, particularly football. Many other forms of games were

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FIG. 1.—Fractured semilunar cartilage with complete detachment except at the posterior end.



FIG. 2.—Transverse fracture of the cartilage.

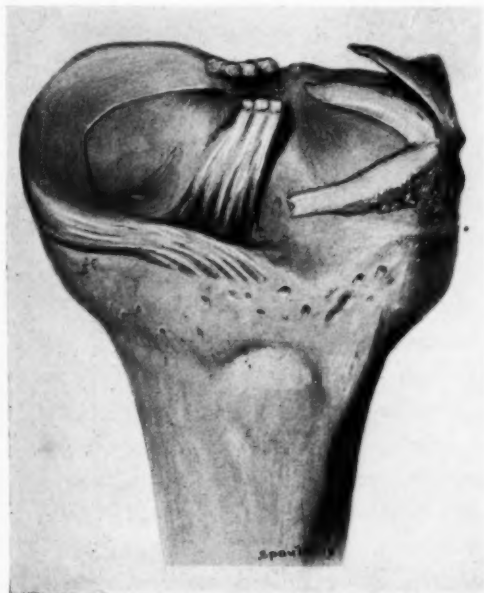


FIG. 3.—Longitudinal tear with detachment of both extremities.

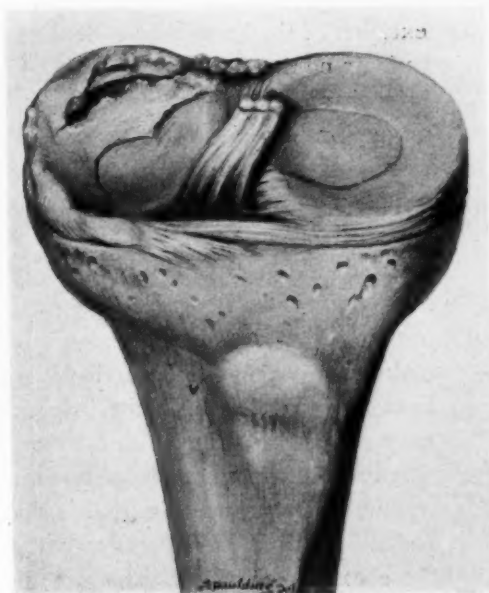


FIG. 4.—Longitudinal tear in the semilunar cartilage.

represented, including hockey, baseball, basketball, tennis, polo, and wrestling. A certain proportion of the derangements was due to automobile accidents.

The primary injury in many cases is mild, resulting simply in a tearing or loosening of the cartilage. In such cases, the disability is usually slight. The treatment of these mild injuries should not be neglected, however, for once derangement has taken place, recurrence with acute symptoms is common.

Direct trauma may also be the cause of derangement of the cartilage, although this origin is much less common. As a rule, cartilage lesions due to direct injury are associated with severe trauma, such as fracture of the patella or tibial tuberosities, or rupture of the crucial ligaments. Occasionally, the cartilage may become jammed as the result of a blow on the inner side of the knee when the joint is flexed. The mechanism of such a derangement is as follows: When the blow hits the knee, it produces extreme abduction of the leg, and the individual, to prevent himself from falling, rises suddenly, thereby rotating the femur inward. (See Section on Mechanism of Injury.)

Disease of either a subacute or chronic nature may eventually lead to a derangement of the cartilage. The symptoms in these cases are often obscure, and the diagnosis is made only by a careful study of the history and after repeated detailed examinations. Local signs and symptoms of slow onset, but increasing in severity, in a case in which there is no history showing of trauma, should be regarded with caution. Not infrequently, when excision of the knee-joint is done in an adult case of tuberculous bone-disease, little or no meniscus is found, showing that cartilage changes take place early in such cases. In one of my cases with a predominance of cartilage signs, an exploratory operation revealed a loose internal cartilage with considerable capsular and synovial thickening. A piece of this infiltrated tissue was removed and, on pathological examination, was found to be tuberculous. Later, the knee went through the typical course of a tuberculous knee.

Arthritis of both the hypertrophic type and the infectious type has been demonstrated as the underlying cause of cartilage hypermobility in some of our cases. When infection of an arthritic nature is present, the cartilage undergoes changes that predispose it to injury. Pathological changes have been noted especially in the infectious destructive type in which there is an extravasation of fluid and detritus in the knee-joint.

Age, Sex, and Joint-involvement.—Derangements of the cartilage are most common in young people, that is, individuals between the ages of twenty-one and thirty. Injuries do occur later in life as well as before adolescence, but these cases are rarer. The age distribution in my reported series ranged from eight to sixty-six years. The majority of the patients were between the ages of twenty-one and thirty, the period in life when an individual is most active and at the height of his physical development. The ages between eleven and twenty years were next in frequency of occurrence.

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The injury is much more common among men than women, a predominance that one expects to find in view of man's participation in athletics and in the more dangerous occupations. In the reported series, approximately 65 per cent. of the cases were males. Other operators have reported about the same proportion in their series.

The joints affected are usually about evenly distributed between the right and left. In our series there was only one more case of involvement of the left knee than of the right.

The Frequency of Involvement of the Internal Cartilage.—Lesions of the internal semilunar cartilage are more common than injuries of the external. In Martin's⁴ series of 449 cases, 92 per cent. were injuries of the inner cartilage. In Henderson's⁵ series of ninety-eight cases, ninety-four were lesions of the internal meniscus. In our series, 79 per cent. were injuries of the internal cartilage. Several explanations of the greater frequency of derangements of the internal cartilage have been advanced. There are, of course, the anatomical variations in the two menisci. The internal cartilage bears a certain relation to the internal lateral ligament and is firmly attached along its entire border to the capsule, whereas the external semilunar has no connection with the external lateral ligament and is much less adherent at its periphery. Consequently, the external cartilage is a more adaptable and mobile structure. Again, due to the weakness of the attachment of the anterior cornu of the internal cartilage, it is easily detached or split when there is a strain on the internal lateral ligament. There is also the possibility that the greater range of internal rotation of the femur, owing to the shape and size of the internal femoral condyle, plays a part in injuries to the internal semilunar. Another explanation is suggested in the accentuation of the direction of the line of force through the inner side of the knee when the foot is abducted, thus throwing a strain upon the internal semilunar cartilage. Galeazzi,³ recognizing a close relationship between the crucial ligaments and the menisci, claims that the preponderance of internal cartilage lesions is due to the fact that in inward rotation of the joint the anterior crucial ligament bears the brunt of the stretching. Surls and Osgood⁶ account for the frequency on a physiological basis, explaining that an individual, to maintain his balance in turning suddenly, twists inward and throws the weight on the other leg. It would naturally be awkward to turn outward and swing the free leg over the other.

When injury is direct, the prominence of the inner part of the knee, as well as the manner in which an individual maintains his balance, described above by Surls and Osgood, may account for the more frequent internal cartilage injuries.

The Mechanism of Derangement.—An explanation of the mode of production of injuries to the semilunar cartilages must be based upon clinical observations and experimental data. The effect of active motion in actual life must, of course, be taken into consideration in weighing the experimental

evidence. Several theories on the mechanism have been advanced. I shall refer to only the most probable ones.

It is agreed, in general, that sudden inward rotation of the femur upon a fixed tibia, with the knee in the position of flexion and the foot abducted, is the important factor in derangement. Most operators also agree that the internal lateral ligament plays an important rôle in derangements of the internal cartilage. This ligament, together with the muscles, resists any separation of the inner femoral condyle and its articulating area on the tibia, which might take place when the knee is in normal extension or slight flexion. Stretching or rupture of the ligament may occur when, with the foot fixed in the position of abduction and the knee slightly flexed, there is a sudden twisting movement by which the body weight is put on the joint and the femur rotated. The relaxation of the ligament causes the tibial surface and the internal femoral condyle to separate, allowing the cartilage to slip into the joint. Then, as the articular surfaces resume their normal position, the cartilage is nipped or jammed. Usually, it is the anterior half of the cartilage that is damaged when the femoral condyle rolls down on it.

Fisher¹ offers another theory on the mechanism. It is his opinion that the tenacity of the internal lateral ligament, and not the relaxation of this structure, is responsible for many injuries. In some instances, when the femur is rotated suddenly inward, the ligament remains intact, thus forming a hinge between the mobile anterior part of the cartilage and the fixed posterior part to which the ligament is attached. As a result, the anterior part of the cartilage may enter the joint, and, upon extension, become nipped, or the anterior or coronary attachments of the cartilage may be ruptured, or tears may occur opposite the fixed posterior part of the cartilage.

Galeazzi,² from his clinical observations and experimental work, concluded that lesions of the semilunar cartilage are more often associated with rupture of the crucial ligaments than is generally believed. It is his opinion that the semilunar cartilages and the crucial ligaments form one functional unit, and that the crucials are put under tension and resist rotation when the knee is in semiflexion. Tension on various parts of the crucial ligaments leads to injury of certain parts of the semilunar cartilages.

The mechanism of injuries of the external semilunar cartilage has not been studied so carefully as that of derangements of the internal cartilage. Fisher¹ advances the following explanation: The anterior horn of the external semilunar may be displaced when, with the knee in the position of flexion, the femur is rotated externally upon a fixed tibia, or when the tibia is rotated internally upon a fixed femur. The posterior horn may be displaced when the femur is rotated internally upon a fixed tibia following or combined with extreme flexion.

Surgical Pathology.—There is a wide variation in the pathology of the cartilages. The types of injuries that it has been possible to determine may be classified as follows:

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- (1) Hypermobile cartilage
- (2) Fractured cartilage
 - (a) Type
 - longitudinal
 - transverse or oblique
 - combination of transverse and longitudinal
 - bucket-handle
 - (b) Site
 - anterior end
 - posterior end
 - middle part
 - periphery
- (3) Totally avulsed cartilage
- (4) Fractures and dislocations
- (5) Cysts

Some of the various types of cartilage fractures found upon opening the joint are illustrated in Figs. 1, 2, 3, 4 and 5.

Attempts have been made to designate the relative frequency of each injury, but such a classification is almost impossible. In Martin's⁴ series, definite fractures predominated; in Fisher's¹ series, the longitudinal fractures held first place, and detachment of the anterior horn and obvious fracture were next in frequency. In our series, the hypermobile cartilage held a prominent place. There is a possibility that the hypermobile meniscus occupies the most prominent place in cartilage pathology, but owing to the mildness of the symptoms following a slight lesion, the joint does not come to operation until a later injury produces more extreme pathology. In severe injuries, the bucket-handle type of fracture is most commonly seen (Fig. 6).

In addition to the specific injury, the cartilage may be atrophied, thickened, calcified, fibrous or nodular. In some cases, it is difficult to discern the cartilage, so changed is its structure, while in other joints there may be no trace of the meniscus. Loose bodies due to the breaking away of parts of the cartilage may be present. Occasionally, a case is seen in which the cartilage has an apparently normal appearance. Henderson,⁵ in recording ninety-eight cases of cartilage derangement, mentioned eighteen instances in which, except for a slight mobility of the capsule, there was no appreciable change despite the presence of the usual symptoms.

The true pathology does not always coincide with the symptoms, that is, intermittent attacks following a fractured cartilage may be mild, whereas a simple hypermobile cartilage may cause severe symptoms. Occasionally, the symptoms may indicate an injury of the internal cartilage, but upon exploration this meniscus is found in perfect condition, and the external cartilage, on the contrary, is deranged. In a certain proportion of cases, the symptoms are somewhat indicative of the pathology. For instance, a sense of weakness

is the predominating symptom in the presence of the hypermobile type of cartilage or in cases of loosening of an extremity. In detachments of the cartilage, slipping and sudden insecurity are the predominating signs.

The Hypermobile Cartilage.—The hypermobile cartilage may be an entity in itself, although it is possible that in many of these cases a marginal fracture exists, but is not observed. The abnormal mobility of the cartilage is the result of a slight injury that loosens the meniscus from its peripheral attachments. If dislocation takes place, the cartilage usually moves toward the

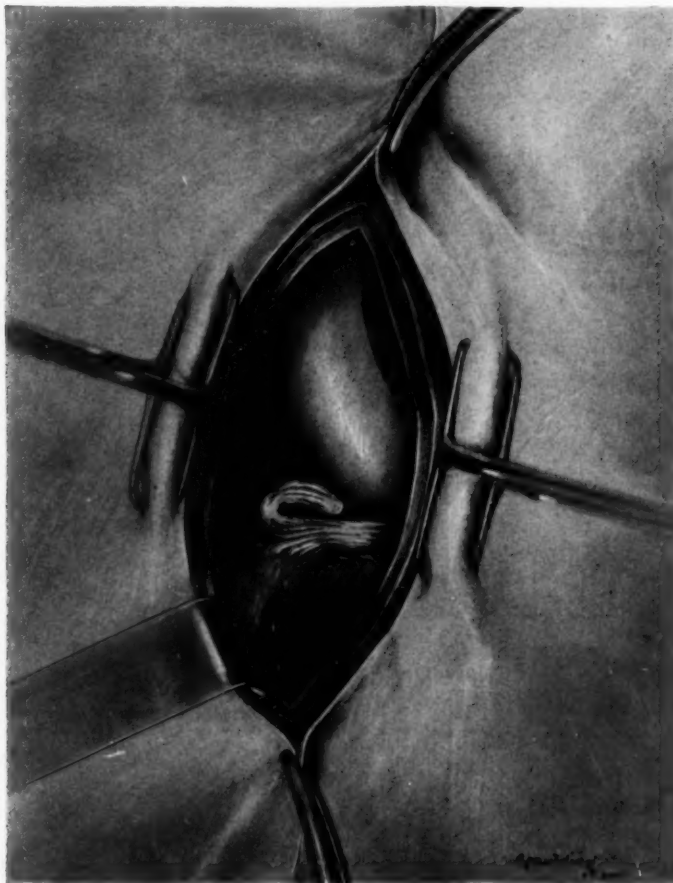


FIG. 5.—Detachment and folding over of the anterior end of the semilunar cartilage. Note the white, shining surface of the internal condyle and the top of the tibia.

centre of the joint, although, occasionally, a luxation toward the periphery is seen. The hypermobile cartilage is common among young girls, occurring as the result of a twist or wrench without history of further injury. The symptoms following the initial trauma are mild, and usually there is no locking of the joint. In this type it is particularly important to immobilize the knee-joint to provide an opportunity for repair; otherwise, the slight hypermobility may be the beginning of more extensive pathology in the

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knee. If treatment is neglected, as often happens because the patient is not seriously disabled, recovery takes place with the cartilage in a loosened condition. A subsequent injury or slipping causes increased hypermobility and the cartilage may be caught between the articular surfaces. With each recurrent slip or pinch, the cartilage swells, thereby becoming more susceptible to further pathology. Total avulsion is not unknown in these cases.

In long-standing cases of a hypermobile cartilage, there are definite evidences of continued local irritation due to the constant rubbing of the meniscus. Villous changes may be felt in the capsule, the edges of the femur may be thinner, sharper, and flatter than normal, or actual hypertrophic changes may be present throughout the entire knee. The following case is one in which such changes were present.

CASE I.—L. L., aged fifty years, was injured twenty-five years previously while playing football in college. From that time the knee had been weak and frequently gave way when walking on uneven surfaces. During the last five years of disability the symptoms had increased.

The knee contained some fluid and was larger than the other knee. All the bony landmarks were prominent, and there was considerable crepitation on movement. The internal cartilage was felt to be large and swollen, and it snapped back and forth in flexion and extension. There were definite hypertrophic changes throughout the entire knee.

An exploratory operation was performed, and the cartilage removed. It was partly torn anteriorly and the remaining part was hypermobile and swollen. The margin of the joint-cartilage was hypertrophic, the articular surfaces were flattened, and the infrapatellar pad was increased in size.

The functional result was fair. The knee no longer slipped and gave way, but the general weakness continued because of the coexistent arthritic changes.

Fractures.—A fracture, tear, or split of the cartilage is a common lesion. It may be longitudinal, transverse or oblique, a combination of the longitudinal and transverse, or the so-called bucket-handle fracture. The tear may occur in the anterior end, the posterior end, the middle part, or along the margin of the cartilage. When the meniscus is torn loose at one of its attachments or when it is torn across, one fragment dislocates. In old-standing luxations the torn ends of the cartilage may become atrophied, or, in an occasional case, thinned.

The split occurs more frequently in the anterior part of the cartilage than elsewhere. If the peripheral attachment is also ruptured, it is not unusual to find a part of the inner edge of the anterior extremity of the cartilage projecting as a tag toward the centre of the joint. The cartilage is usually displaced inward, leaving a noticeable gap, which can be felt on palpation. Only rarely does the anterior tip displace outward or buckle backward, as shown in the accompanying illustration (Fig. 5). The tear is followed by symptoms of "catching" or "giving way," even if the cartilage still remains attached at its middle part. The normal cartilage thrust cannot be felt upon examination.

An isolated fracture of the posterior end is rare. It may occur in con-

nection with actual separation of the mid-portion of the cartilage or in total avulsion of the meniscus. Fisher,¹ in his description of the production of a posterior split or displacement, refers to Lang's theory. The latter is of the opinion that during forcible external rotation of the femur upon a fixed tibia, combined with flexion, the posterior part of the internal condyle sweeps across the posterior end of the cartilage, and if the flexion is extreme, the semilunar may be split or detached. Tenney² has shown that, in forcible abduction of the leg, the upper attachments of the internal lateral ligament may be ruptured, and the posterior part of the internal condyle slip over the posterior end of the semilunar and roll up the cartilage.

I have seen only one case—a fracture of the posterior third—in which a tear of the posterior end was demonstrable with practically no evident changes in the rest of the cartilage.

The patient was a man, twenty-two years of age, who, while playing basketball, felt something slip on the inner side of the left knee, and fell. The knee swelled considerably. From that time complete extension or flexion was impossible. During the following two months, the knee slipped out seven or eight times.

About fifteen months after the first attack, the knee was opened and the cartilage removed. A part of the cartilage at the junction of the middle and posterior thirds was entirely free. At this point the attachment of the cartilage to the ligament could not be removed, but since the strip was very narrow; it did not seem that it would cause trouble if allowed to remain in the joint. At the anterior tip the cartilage was broad and slightly thickened.

Examination six months after operation showed the knee to be in satisfactory condition. The strength and function were rapidly returning to normal. The patient wrote six years after the operation that he was satisfied with the result.

Fractures of the middle section of the cartilage are not uncommon. In such cases the cartilage often folds over on itself, bringing the razor edge away from the crucials. There is always a definite history of slipping, followed by almost total disability, and, in case of displacement, by flexion deformity. In the following case of a tear of this nature, the patient experienced such severe symptoms that she fell two or three times a day for a period of more than two years.

A girl, seventeen years of age, attempting to rise from the floor with the legs crossed, felt the knee lock, and could not straighten her leg. Fluid remained in the joint for two weeks. A second attack occurred a few months later. The knee was actually locked only twice more throughout the long period of disability, but the joint gave way frequently, sometimes as often as two or three times a day. Finally, the cartilage was removed according to the regular technic. The internal meniscus was found fractured in its middle part. The external cartilage was also excised as its posterior part was displaced and its anterior tip traumatized. The result was a perfect functional knee with full strength.

Marginal Tears.—It is possible that marginal splits are more frequent than is generally supposed, as they are easily overlooked, particularly in the hypermobile type of cartilage. In an occasional case, an incomplete transverse fracture, often combined with a longitudinal tear, may occur near the

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periphery of the cartilage. Isolated longitudinal splits also may be found along the border of the disc.

Types of Fractures.—*The Longitudinal Fracture.*—Longitudinal fractures may occur in any part of the cartilage, or they may involve its entire length. The usual site of these fractures is about the junction of the anterior and middle thirds. The tear may be single or multiple, or it may be combined with a transverse fracture, thus producing a pedicled tag. In many cases the fracture occurs in a somewhat oblique rather than a true vertical plane. Strain upon the peripheral attachments is probably responsible for these longitudinal splits. Surls and Osgood⁶ offer the explanation that a longitudinal fracture is probably the result of secondary damage to a cartilage already in a relaxed condition as the result of a previous trauma. The



FIG. 6.—The "bucket-handle" type of fracture, showing the cartilage folded over in the intercondylar region.

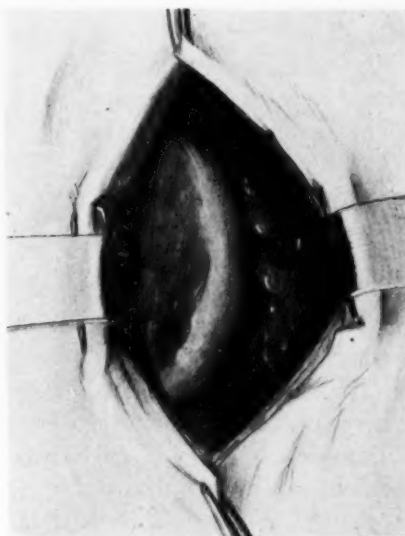


FIG. 7.—Loose internal semilunar cartilage, showing hypertrophic subpatella lipoma.

cartilage gets caught between the bony surfaces, there is a pull on the peripheral margin, and the pressure of the femoral trochlea holds the cartilage firm. The result is a long split near the anterior extremity of the meniscus. Wilson and Cochrane⁷ call attention to the occurrence of a longitudinal fracture in the middle part of the cartilage when its anterior end is snapped, but without the attachment giving way and with the peripheral attachments remaining intact. When the small inner crescent formed by the longitudinal tear swings in between the condyles, the fracture is called the bucket-handle type (Fig. 6).

The Transverse and Oblique Fracture.—According to Fisher's¹ observations, the common site of these fractures is the level of the posterior fibres of the internal lateral ligament. Fisher finds that the oblique and incomplete fracture occurs most frequently with the fissure running horizontally only

part way through the cartilage so that the fragments move upon each other. Wilson and Cochrane⁷ believe that the cartilage is likely to be torn across when a part of the anterior extremity of the cartilage gets caught in the intercondylar notch and the peripheral attachments remain intact. If the fracture is complete, the anterior fragment may become entirely detached and form a loose body. In other cases, the anterior half of the cartilage, being abnormally mobile, may become caught between the joint surfaces with resulting locking of the joint. Fisher¹ has emphasized the importance of careful inspection of the cartilage to detect these fractures, for when the meniscus is viewed from above, it may appear normal owing to the obliquity of the tear.

The Bucket-handle Fracture.—(Fig. 6.) A type of fracture seen frequently in severe injuries is the so-called bucket-handle tear. This is a longitudinal split in which a loop of the cartilage becomes detached and enters the intercondylar notch, resembling the handle of a bucket. The production of these longitudinal fractures has already been explained under "The Longitudinal Fracture." The bucket-handle type of tear also occurs when, with the knee partly flexed and the foot rotated outward and abducted, sudden extension causes the condyle of the femur to jam down on the cartilage at about the junction of its anterior and middle thirds. The section detached enters the intercondylar notch.

The Totally Avulsed Cartilage.—A complete tearing of the cartilage from its attachments is not common. It is produced only by a very severe trauma.

Associated Pathology.—Early Changes.—Immediately following the injury there is extravasation of synovial fluid, which gradually grows thicker and more stringy. Free blood is present in the joint. The displaced meniscus always causes a synovitis.

Later Changes.—The synovial membrane becomes more fibrotic with each attack. The capsular ligaments are thickened as in any chronic joint process. There is usually atrophy of the quadriceps group. Wallace and Permar,⁸ who made a careful study of the pathology in seventy-one cases of derangements in which arthrotomies had been performed, found proliferative inflammatory changes in the synovial membrane, which had given rise to pannus or a granulation tissue over the articular cartilage. In long-standing cases this cartilage had become eroded or even destroyed under the heavy pannus. Wallace and Permar also found that microscopically there was marked thickening of the connective tissue, with a large increase in the size and number of the small vessels, especially the capillaries. As to the fluid, there were quantities present in old-standing cases, of a serous, yellow, brown, or bloody character. Further, the fat pads showed much congestion, thickening, and induration. The fat tissue was compressed and atrophic as the result of marked fibrosis. In chronic cases the infrapatellar fat pad was enlarged, œdematous, and hæmorrhagic (Fig. 9).

Occasionally one sees small villi and fatty tabs attached to the menisci

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anteriorly. These tabs seem to be parts of the cartilage which have been stripped off, but not totally detached, and which have become hypertrophied. Pinching of these tabs causes sudden pain. If any bone or ligamentous damage was associated with the original injury, loose bodies may be found.

Not infrequently an arthritic process is associated with the deranged meniscus. The presence of a local hypertrophic arthritis in one knee-joint following a history of trauma suggests a cartilage injury. Hypertrophic changes take place at the point of irritation and are recognized by the prominent ridges, thinned cartilage on the bony surfaces, and a flattened appearance of the condyles and tibial tuberosities. Occasionally the changes

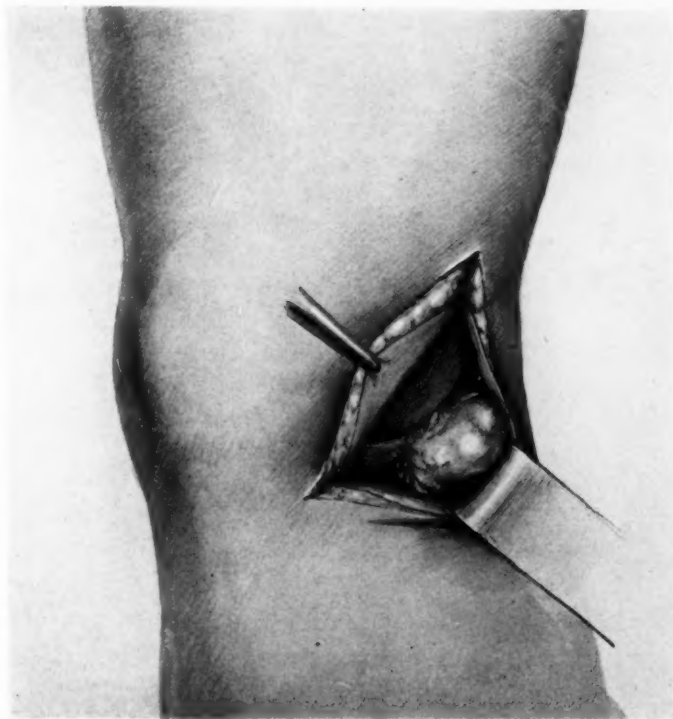


FIG. 8.—Cyst of the semilunar cartilage.

are associated with loose bodies and hypertrophic fringes. These changes may become so marked that joint symptoms persist even after the removal of the cartilage.

Cysts of the Semilunar Cartilages. (Fig. 8.)—Since the year 1904 when this lesion was first described by Ebner,⁹ practically all contributions on the subject have opened with a statement calling attention to the rarity of the lesion. From a careful survey of the literature, I should conclude that these cysts are far more common than is generally estimated. The total number of cases reported from 1904 to June, 1929, in so far as I have been able to ascertain, amounted to eighty-nine. This total is at considerable variance with the list of cases reported recently by several writers, one of whom estimates the

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number as low as twenty-six. My observations are outlined in sequence in the accompanying chart. It will be noted that during the period from 1904 to 1927 thirty-one cases were reported, whereas from the year 1927 to June, 1929, fifty-eight cases were reported. This difference in the number of cases in the two periods suggests the possibility that no report was made on many of the earlier cases. Furthermore, the series of cases presented in later years by some operators are relatively large in contrast to those reported earlier, Mayer¹⁰ citing nine cases in 1927, Bristow¹¹ eleven in 1928, Ollerenshaw¹² eighteen, and Campbell and Mitchell¹³ ten in 1929. Some writers have mentioned that while some of their colleagues met with the lesion in their practice, they made no report of it.

Our experience with these cysts has been limited to two cases, which I add to the reported observations, bringing the total number of cases up to ninety-one.

To this list there should probably be added one case of a lesion of the external meniscus with cystic formation referred to by Bristow,³⁴ a second

Table of Reported Cases of Cysts of the Semilunar Cartilages

		External	Internal	Total No. of cases
Ebner ⁹	1904	1		1
Schmidt ¹⁴	1906	1		1
Kroiss ¹⁵	1910	1		1
Allingham ¹⁶	1910		1	1
Eden ¹⁷	1911	1		1
Riedel ¹⁸	1915	6		6
Hammer ¹⁹	1920	1		1
Ollerenshaw ²⁰ (2 cases by Furniwall)	1921	5		5
Phemister ²¹	1923	2		2
Campbell ²²	1924	1		1
Jean ²³	1924	3		3
Fisher ¹	1924		1	1
Pelizaesus ²⁴	1926	2	1	3
Allison and O'Connor ²⁵	1926	2	1	3
Tavernier ²⁶	1926	1		1
Zadek and Jaffe ²⁷	1927		1	1
Edington ²⁸	1927	1		1
Mayer ¹⁰	1927	6	3	9
Kleinberg ²⁹	1927	1		1
Heusser ³⁰	1928	3		3
Bristow ¹¹	1928	9	2	11
Pandalai ³¹	1928		1	1
Ollerenshaw ¹²	1929	14	4	18
Delchef ³²	1929	2		2
Campbell and Mitchell ¹³	1929	10		10
Nutter and Blew ³³	1929	1		1
MacAusland	1929	1	1	2
		75	16	91

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case mentioned by Surls and Osgood,⁶ and a third case of a polycystic fibroma of the external semilunar cartilage reported by Serafini,³⁵ of which I was unable to obtain a record.

Personal Case of Cysts of Semilunar Cartilages.—CASE II.—J. P., a man aged thirty years, had complained of pain in the region of the left knee for ten years. There was no record of injury. The man simply had noticed the presence of a small mass on the outer side of the knee at the level of the joint.

Examination was essentially negative except for a small semi-bony mass in the region of the outer cartilage. There was slight tenderness to deep pressure. The diagnosis of a cyst of the semilunar cartilage was given. The cyst and the cartilage were removed. Unfortunately a microscopical report could not be obtained owing to the over-decalcifying of the specimen. Four years after the operation, the patient had a perfect functional knee.

CASE III.—J. S., a man aged twenty-seven years, had complained of pain and stiffness in the left knee for two years, which had followed a fall while running. There was no swelling nor increase of fluid in the knee-joint. Motions were normal. In line with the joint there was a mass about the size of a small nut. There was no tenderness over the cartilage. A röntgenogram showed increased density in the line of the outer joint space. A cyst of the external semilunar cartilage was made as the diagnosis. The cartilage and cyst were removed. Three years after operation the patient had a perfect functional knee.

Occurrence.—Cysts occur far more frequently in connection with the external semilunar cartilage than the internal. In seventy-five of the ninety-one cases reported, the outer meniscus was the seat of the lesion. It is impossible to explain this predisposition of the external cartilage.

The age incidence varies from five or six years to the middle thirties, with the average age being between twenty and twenty-five years. Males are predominantly affected, in the relative proportion of three males to one female.

Pathological and Histological Considerations.—The cyst is approximately hemispherical in shape. In volume it may vary from the size of a pea to that of a good-sized prune. It is always of the sessile type, extending from one-half to one inch along the cartilage. The location of the cyst is fixed on the external border of the inner or outer cartilage, at about the junction of the anterior and middle thirds.

The cyst is multilocular and filled with a transparent gelatinous substance. Bristow¹¹ in his consideration of the pathology states that usually the swelling extends through the extra-synovial tissue and may also penetrate into the substance of the fibrocartilage itself. It is the opinion of some operators that the cysts are closely adherent to the capsule; Bristow, on the other hand, found that while the cysts penetrated deeply into the joint, they were not connected with the capsule. Rather, says Bristow, they "come forward from the synovial membrane and occupy the space usually filled with the extra-synovial fatty and areolar tissue.*

Symptoms and Diagnosis.—The patient complains of a dull ache in the knee and of some lameness. The pain is aggravated on movement, especially

* Bristow: Jones Birthday Volume, p. 273, 1928.

on acute flexion and complete extension. At times there is limitation of motion. In the region of the cartilage there is a visible swelling, which is firm and resistant to pressure and which may be tender. The cyst varies in size. It usually attains its maximum volume within a few weeks of its appearance, and then remains stationary. The cyst follows the cartilage in movement, and it is more prominent in extension than in flexion when it is drawn into the joint. These symptoms may be of a few weeks' or several years' duration.

The majority of writers are of the opinion that a cyst has never disappeared spontaneously. Campbell and Mitchell¹³ question this view, since in one of their cases the tumor subsided after a short time, although the symptoms persisted; in another case the symptoms were recurrent; and in still another the tumor disappeared and the pain was relieved by aspiration of the contents of the cyst.

The clinical picture naturally suggests the internal derangements of the knee that are met with more frequently in practice. A careful examination of the swelling will establish the diagnosis. Usually the röntgenogram is negative, but it may show a shadow in the soft tissues in the involved region, as was seen in one of our cases.

Treatment.—The best treatment consists of the removal of not only the cyst itself, but also the affected semilunar cartilage, according to the regular technic used in removing an injured meniscus. Recurrences have been reported when the cyst alone was removed. Care must be taken in removing the cyst to preserve the joint capsule, for otherwise there will be difficulty in securing proper approximation. The after-care is similar to that following the usual operation for the removal of the meniscus.

The prognosis as to the complete recovery of function and strength in the knee depends, as in other derangements, upon the presence or absence of the structural changes within the joint. If the cyst has been of long standing, the pressure from it may have damaged the joint structures. In older individuals mild arthritic changes are usually present in the knee. The prognosis in these cases must, of necessity, be guarded. The outlook in cases of young patients is excellent, and in older patients is more favorable the earlier operation is performed.

Symptoms of Cartilage Pathology.—At the time of injury the patient always experiences severe pain. In addition, there is often a sensation of something giving way in the joint, and a definite click may be audible. In early teaching, locking was considered to be the most important diagnostic sign of cartilage pathology, but it is now clear that this clinical manifestation occurs with much less frequency. In our series locking was present in less than one-third of the cases. It is always present when fracture-displacement occurs. There is considerable effusion whether locking is present or not. Local tenderness is always present. In general, the symptoms resemble those of a sprain.

Following the initial trauma, the symptoms persist for several weeks.

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The acute pain passes away soon after the injury, leaving the joint aching and sore. Frequently there is pain in the region of the hamstrings and at the top of the patella, but the presence of this pain in no way indicates the extent of the damage to the cartilage. If the effusion is very marked, pain is present, but usually the effusion subsides in the course of two weeks.

The initial attack may be followed by others, some slight, some grave in character. While the recurrent attacks tend to be less severe than the primary one, conversely, they occur from only slight twists of the knee. Definite symptoms of pain, effusion, tenderness, and weakness accompany each attack. The effusion in repeated attacks is less and may persist for only a few days, but this intermittent effusion permanently damages the capsule and weakens the joint. If locking takes place in the subsequent attacks, it is usually transitory, and the patient soon learns to straighten the knee by manipulation. An individual experiencing recurrent attacks suffers intensely from the sense of fear that "something will give way in the knee," and, if the patient is young, he is deprived of the pleasure of participating in sports.

Diagnosis.—In the majority of cases, diagnosis of a derangement of the cartilage is not difficult, although it is practically impossible to make a definite decision as to the actual extent or location of the damage. A knowledge of the mode of production of a derangement is important. A detailed history of the case must be obtained, which in most instances will show a sudden onset of symptoms following an injury. Among the reliable diagnostic signs are slipping, local pain and tenderness over the site of the involved cartilage, effusion, swelling, locking of the joint, and the absence of the cartilage-thrust. Recurrent periods of disability with frequent slipping, a "sense of weakness or insecurity," and "fear that the knee will give way" are extremely important features. Usually the repeated attacks are less severe than the initial; on the other hand, they occur from slight injury.

The tenderness is marked in recent cases and may persist for months after the acute attack. It can be elicited by pressure on the articular line halfway between the internal lateral ligament and the patellar ligament, and in the region of the anterior end of the cartilage. Some tenderness may also exist slightly behind the centre of the internal margin of the meniscus. The determination of the presence or absence of the cartilage-thrust, which in the normal knee can be felt upon extension, is important in making the diagnosis. There is no difficulty in deciding upon this factor unless there are chronic thickening and tenderness throughout the inner capsule.

In long-standing cases, there may be some fluid in the joint, and one may elicit a slight click. Motions are usually normal, but if the joint is acute there is limitation of flexion, and forced extension is painful. If the cartilage is locked between the condylar surfaces, the knee cannot be straightened or fully flexed. If the injury has been extensive there is thickening at the attachments of the cartilage to the ligaments, and hypermobility is present. A chronic synovitis is present in a cartilage displacement.

While it has been stated above that it is almost impossible to arrive at a decision as to the exact pathology, in a certain proportion of cases one is able to determine definite mechanical changes sufficient to account for the symptoms and to warrant operative interference. For instance, in cases of hypermobile cartilages, there are usually irritative changes about the inner head of the tibia, due to the mild hypertrophy resulting from an injury in this region, or produced by the repeated passing of the loose cartilage over the tibial head. In cases of fracture of the meniscus there is a persistent sense of fear, an unwillingness to enter into sports, caution in going up and down stairs, and a certain weakness persists as in fractures of the carpal scaphoid. In displacements of the posterior cornu, there is usually no tenderness in the anterior aspect and there is more pain posteriorly.

Occasionally it is difficult to arrive at an exact diagnosis because of the presence of confusing symptoms, or because of the extent of the injury. In some cases the history may show an injury followed by periodic swelling, but there is no "giving way" of the joint and no pain. In other cases there may be little effusion following a severe injury, yet upon exploration the cartilage will be found torn. There is also a certain group of cases in which there is no history of a trauma or an infectious process, yet all the local symptoms of a cartilage derangement are present. In still other cases symptoms may point to an injury of the internal meniscus, but upon exploration the external cartilage is found to be involved.

Röntgen films in the anteroposterior and lateral planes and stereoscopic views of both knees should always be taken. While it is questionable whether röntgen films are of definite value in revealing actual cartilage pathology, they do rule out the presence of other lesions, such as calcified loose bodies, fractures, exostoses, or chronic arthritic changes. Dr. Arial George⁴⁰ concludes from an extensive study of the value of röntgen films in the diagnosis of cartilage derangements that, with special technic, it is possible to demonstrate the displaced meniscus in a majority of cases. He bases his opinion upon the fact that, in the average case, it is possible to visualize the normal internal or external cartilage or the shadow produced by it. He has made many dissections of amputated knees and found that the shadow he identified was the semilunar. Further he secured absolute proof by painting the semilunar specimen with white lead and taking further röntgen films. If this shadow is absent, the cartilage must be displaced. The greatest difficulty in demonstrating a displaced cartilage is that in many cases the cartilage has returned to normal position at the time of the röntgen examination. Therefore, it is only when the cartilage is still displaced that it can be demonstrated.

From my experience I cannot agree that cartilage pathology can be demonstrated as frequently as Doctor George states. In our cases röntgen films have seemed to be of value only when calcification had taken place.

Pneumarthrosis for the purpose of radiographic study is being used more frequently as a diagnostic aid, and some operators are finding it of value. Its

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use should be limited to those cases in which a definite diagnosis cannot be made easily. Bircher⁴¹ inflated nine joints with oxygen, carbon dioxide, or nitrogen gas, and secured positive findings of an internal semilunar injury in eight cases. Kleinberg^{42, 43} believes that pneumarthrosis is a safe and simple test, but he reserves it for the study of doubtful lesions. He also stresses the importance of correlating the radiographic findings with the clinical examination.

Differential Diagnosis.—Loose Bodies.—Loose bodies can usually be felt as round masses by the patient, and they often move about in the joint. The symptoms, therefore, are seldom localized at one spot for any length of time. Pain and swelling are not acute unless the bodies cause locking of the joint. Locking, when it does occur, causes a sharper pain and more extensive swelling than in a semilunar derangement. The locking is only transitory, however, and is not caused by any particular movement of the joint. No tenderness exists over any particular area as in derangements. Röntgen films demonstrate a loose body that is calcified. The presence of more than one body helps to confirm the diagnosis.

Lipomata may give rise to locking of the joint, but the other symptoms accompanying this lesion do not resemble those of a cartilage derangement. Lipomata are usually associated with over-exercise rather than with trauma. When acute, they are tender and can be definitely outlined, usually on the outer side of the upper quadriceps pouch. The symptoms are mild and no pain is elicited on pressure.

Osteomata occur in hypertrophic joints. The pinching of the capsule and the locking of the joint may cause some confusion. A differential diagnosis is clearly made from röntgen films.

Crucial Ligament Injuries.—Rupture of the crucial ligaments usually occurs in severe injuries of the knee and is followed by rapid hæmorrhage and effusion. Not infrequently this tearing is associated with injuries of the internal meniscus and the internal lateral ligament. In severe injuries the actual pathology in the crucials may not be recognized until the joint is opened. In mild cases the presence of undue anteroposterior motion and lateral mobility with the knee in flexion suggests a crucial injury. If the anterior crucial ligament is ruptured, the lower leg can be displaced anteriorly, hyperextended, and rotated inward. When the posterior ligament is damaged, a less frequent injury, the tibia can be moved backward abnormally with the knee fully extended.

Lesions of the Internal Lateral Ligament.—Occasionally it is necessary to differentiate an isolated rupture or sprain of the internal lateral ligament from a deranged cartilage. As a rule, the ligament, which is very tough, is seldom damaged except in a severe injury which doubtless affects the meniscus at the same time. When differentiation is necessary, the location of the pain in the inner side of the joint and the tenderness over the attachments, particularly the lower attachment, as well as the free lateral move-

ment of the leg when the thigh is fully extended, are significant signs. There is no locking or other sign indicative of a meniscus damage.

Bone Injuries.—The diagnosis of bone injuries, such as fracture of the tibial spine, can usually be determined by röntgen films.

Traumatic Bursitis.—In traumatic prepatellar bursitis resulting from injury there is localized circumscribed swelling and fluctuation over the patella. Differentiation from an intra-joint lesion is not difficult.

Hypertrophy of the Infrapatellar Fat Pad.—Enlargement of this pad, so-called lipoma arborescens, is present in practically all knee-joint pathology, whether of traumatic or infectious origin. The pad can be observed and felt to be enlarged. Complete extension may cause pain. Following any exercise there is usually slight pain and effusion.

Exostoses.—Exostoses are common in arthritic lesions, occurring especially between the tibia and the femur on the inner side. They may give rise to painful pinching in the joint, but it is usually transitory and is not followed by effusion. Exostoses can often be felt clinically and can be definitely determined by radiographic examination. In most cases there are arthritic changes in other joints.

Slipping Patella.—It is often difficult in young girls to differentiate between a slipping patella and a derangement of the meniscus. The history showing the nature of the injury is important. Examination shows that with the leg at rest in flexion, the patella is found to the outer side of the knee-joint, but when the patient tries to get up or extend the leg completely, the patella suddenly snaps into place. An attempt to displace the patella is usually accompanied by a great deal of pain and fear.

Synovial Membrane Lesions.—The symptoms due to *synovial fringes*, while occasionally suggestive of a deranged cartilage, are not so acute at the initial injury, and they tend to be more localized. Creaking of the joint is common, and usually there is enlargement of the infrapatellar pad. Slight effusion follows each pinching. There is often a perceptible enlargement over the site of the local symptoms.

A localized fold of synovial membrane may be confused with a deranged semilunar cartilage. It is usually the result of synovitis and is a palpable membranous ridge.

Traumatic Periosteitis of the Femoral Condyles.—These cases, occurring as the result of a direct trauma, may be differentiated from a lesion of the meniscus by the location of tenderness on the condyle. In some cases there may be a flexion contracture.

Prognosis.—Three factors influence the prognosis: the number and severity of the attacks, the presence of arthritic changes, and the age of the patient. The average case, if treated properly following the initial injury, either by conservative or by operative measures as the case requires, obtains a resulting joint that is stable and painless without any restriction of movement. This is true of the adolescent case, the adult, or the young child. If

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a slight weakness or tendency to slipping persists in these cases that are treated early, it is probably secondary to a weak quadriceps.

In a long-standing case, the prognosis following operative removal of the cartilage must be somewhat guarded. The outcome from operation must of necessity be questionable in long-standing cases in which the meniscus is badly torn or comminuted. If the ligaments are relaxed as the result of repeated effusions, operation may restore motion to the joint, but instability persists. In any long-standing derangement, and particularly in those with numerous and severe attacks, arthritic or periartritic changes take place, regardless of the age of the patient. It is impossible to predict an excellent result in such cases, for the removal of the cartilage will not overcome the arthritic changes. However, many of these neglected cases will be improved by the removal of the mechanical defect, and some functional improvement may be expected.

In elderly cases in which the cartilage changes are often secondary to a local arthritis, the prognosis is poor. Usually these patients are undernourished, and the arthritic process involves several joints. Some type of protective apparatus is the best form of treatment.

In our series of cases, in some of which operation was performed following the primary injury and in others following repeated attacks, satisfactory results were obtained in about 91 per cent. Motion and functional use were regained. In the few instances in which there was a recurrence of symptoms, the cause could not be attributed to the cartilage pathology, but rather to the presence of some other lesion, such as a loose body, which was overlooked at operation.

Cases in which a definite diagnosis is made and operation advised, but refused by the patient, often develop severe hypertrophic changes in later life. In view of this danger, the importance of early operation is to be appreciated.

Treatment.—The nature of the treatment depends in the average case upon whether the attack is the initial or a recurrent one. The primary attack, if slight and accompanied by no mechanical changes, can often be treated satisfactorily by conservative measures. Severe initial injuries, or recurrent cases presenting a definite history of injury and typical symptoms of an acute nature, call for operative interference.

Conservative Treatment.—Subsequent to an injury, the knee, if not locked, should be immobilized in extension to prevent all movement. If necessary, fluid can be aspirated. The duration of the period of immobilization varies according to the severity of the injury. In the average case it is three weeks. This procedure is imperative regardless of how slight the injury or how mild the symptoms. Very often a blow or twist will cause only slight disability and there may not even be fluid in the joint. Unfortunately, the treatment of these slight injuries is frequently disregarded.

When locking has occurred, reduction of the displaced cartilage followed by immobilization is the routine procedure. The displacement is easily

recognized by the flexed position of the knee and the presence of pain in the region of the cartilage on any attempt at forced extension. Reduction should be made as early as possible before repair tissue has organized and before the cartilage has undergone changes in shape from pressure.

The method of reduction is not important provided extension is obtained. It is most essential, however, for the surgeon to make sure that complete extension has been obtained. Upon the accomplishment of reduction, the pain disappears, the knee can be held voluntarily in complete extension, and the patient is confident that the correction has been made. In the majority of cases reduction is simple, but in long-standing cases it may present difficulty, and occasionally it may be necessary to repeat the process several times, even under an anæsthetic.

The method of reduction used in our clinic is the Jones⁴⁴ procedure, consisting of movements of acute flexion and lateral deviation and rotation inward to open the joint space, followed by full extension. A firm flannel bandage is then applied from the mid-calf to the mid-thigh, with the knee straight. This is worn for protection as long as the fluid persists, usually for a period of a week or ten days. Baking, massage, and gentle passive motions are then begun. Walking is allowed in a week or ten days, depending upon the sensitiveness and swelling. Strain upon the internal lateral ligament and repair tissue is prevented for several months by wearing a lift on the inner side of the sole and heel, which forces the patient to walk with the foot inverted.

The majority of primary cases of the hypermobile type respond to this treatment. The fractured cartilage eventually comes to operative treatment. The recurrence of symptoms in some cases has been explained by Fisher¹ on a physiologic basis. He noted that the peripheral margins of the cartilage, where the blood-supply is greater, recover more quickly from an injury than the concave edges or the centre of the cartilage, which are not so well nourished. In fact, repair may fail to take place in the central and inner parts. Fisher also discovered that in fractures the edges of the fragments became smooth and rounded and even after a long period of immobilization they did not unite.

Operative Treatment.—Indications.—Following an initial attack that has left the joint locked in flexion, which cannot be reduced by manipulation, removal of the cartilage by operation is necessary.

Operation is the only means of cure in recurrent cases presenting a definite history of injury followed, upon slight provocation, by an intermittent return of the symptoms of pain, slipping, and tenderness. A chronic or recurrent synovitis is indicative of a pathological change within the joint. Failure to remove the cartilage in these cases not only leaves the patient physically handicapped, but there is the probability that the presence of this derangement will lead to joint changes. (See section on "Prognosis.")

In the presence of arthritic complications, the advisability of operation must be considered carefully, for arthrotomy is not warranted if the patient

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will not receive benefit. Several influencing factors are the age of the patient, the location of the arthritic lesion, that is, whether monoarticular or generalized, the stage of the infection, and the part played by the cartilage derangement and the arthritic element in producing the present symptoms. If the changes are localized and the disease is progressing, removal of the source of irritation is imperative.

In a certain proportion of cases in which it is impossible to determine pathology sufficient to cause the existing symptoms, the advisability of exploratory arthrotomy must be considered. One must weigh carefully the symptom complex and the physical manifestations, and one must appreciate the seriousness of irritative changes of mechanical origin.

Technic.—Pre-operative Care.—In view of the atrophy of the quadriceps, which is present in the average case, it is well to carry out a course of muscle-training for this group before operation. The patient, by contracting the quadriceps voluntarily fifty times, several times daily, both before operation and early in the convalescence, even before passive motion is started, can aid in hypertrophying this muscle. Not infrequently the persistence of weakness after operation is due to the loss of musculature, a weakness that the patient cannot differentiate from the original cartilage symptoms.

The preparation for arthrotomy of the knee must be carried out meticulously. While knee-joint surgery, through the introduction of careful asepsis and the development of perfect operative technic, has progressed to the stage where it is no longer avoided, still every precaution must be taken, as the knee does not tolerate infection.

The patient enters the hospital two days before operation. The leg from the ankle to the groin is given a dry shave, washed with soap and water for ten minutes, and scrubbed with alcohol and ether. On the night before the operation, the leg from the ankle to the groin is painted with 3 per cent. iodine, the leg is held elevated until dry, and a sterile dressing is then applied, which remains on until the patient is on the operating table. A final preparation of 5 per cent. iodine is given to the same area just before operation.

Excision of the Cartilage.—Rigid asepsis must be practised. A tourniquet is applied to prevent operative hæmorrhage. During the application of the tourniquet, the surgeon is careful not to touch the skin. The knee is properly draped, and flexed over the table at an angle of 90 degrees. A sterile towel is placed over the knee, through which the line of incision is determined and marked by thumb pressure (Fig. 9). The towel is then removed, and an incision made. Various types of incisions are in use, including the transverse, the vertical, and the curved. Most incisions tend to penetrate the joint between the patella and the corresponding lateral ligament. Some operators recommend a longitudinal patellar incision with division and displacement of the patella, and find that it gives satisfactory exposure. The particular type of incision is not important provided it allows sufficient exposure of the meniscus, makes possible its removal, and

permits inspection of the remainder of the joint. We advocate either the curved incision of Jones⁴⁴ (Fig. 10), or a modification of it. In view of the advisability of examining both cartilages, since not infrequently it is impossible to determine from the location of the symptoms which meniscus is affected, a modification of the Jones incision which permits direct vision to both cartilages has been adopted as the routine procedure in our clinic. This incision begins above the inner condyle, crosses the patellar tendon without severing it, and terminates on the external condyle at a point opposite the point of origin.

The knife is then discarded, and the skin swabbed first with a sponge



FIG. 9.—Excision of the semilunar cartilage. Determination of line of incision through towel.

that has been wet in Harrington's solution, and then with a sponge that has been wet in salt solution. Towels are now clamped over the skin to prevent touching it during the remainder of the operation.

With a fresh knife, an incision of sufficient length to allow proper exposure of the cartilages is made through the fascia, synovial membrane, and joint capsule, in the same line as the original incision. Care is taken not to cut the patellar tendon. Pathological changes in the capsule as well as the amount of fluid are noted. The joint is exposed, and a thorough inspection made of the interior. I want to place particular emphasis upon the

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examination of the joint region. In addition to the derangement of the cartilage, there may be contributing pathological factors, such as loose bodies or enlargement of the fat pad, which are likely to be overlooked if the exploration is not complete. The persistence of any pathology in the joint may lead to a recurrence of the symptoms. In my opinion, the joint cavity should be explored with the gloved finger, for only by this method is it possible to determine the presence of loose bodies. (This step is not approved by some of my colleagues, but I believe that if the technic is carried out carefully there is no danger in the procedure.) To complete the inspection, the other cartilage and the crucial ligaments are examined.

The cartilage is now dissected from its attachments (Fig. 11). Regardless of the extent of the pathology in the cartilage, total excision is generally advisable. Even when the cartilage is found to be hypermobile, it is well to remove the entire meniscus. Rarely in a fracture of the anterior tip of the cartilage, when the posterior part remains firmly attached, removal of the broken tip alone is justified.

During the removal of the cartilage it is kept under tension. To obtain better exposure it is often advisable to rotate the tibia inward or outward, or to pry the femur from the tibia with a blunt dissector. The anterior end of the meniscus is loosened by means of a sharp knife and removed. The ends are grasped with heavy Ochsner snaps and held tightly. The dissection now follows along the internal lateral ligament. The posterior part is cut with scissors whose curve conforms to the convexity of the table of the tibia. Care must be taken not to injure the femoral cartilage, the lateral ligament, or the crucials.

The joint is then examined for fat tabs, loose bodies, lipoma, or other pathology. In chronic knee-joint lesions the infrapatellar fat pad is often enlarged, and the removal of the entire structure or a large part of it is advisable. Hypertrophic bony changes are rarely interfered with, for once the irritating factor has been removed, spurs tend to be absorbed or their sharp edges become rounded, thereby lessening the irritation.

Throughout the operation sponges are used only once. It is not necessary to wash out the joint as no hæmorrhage will occur if a properly applied Esmarch bandage has been used.

The wound is closed in layers; the synovial membrane is sutured with interrupted fine catgut, the capsule with interrupted catgut No. 2, the fascia with continuous catgut No. 1, and the skin with silkworm gut or catgut. A sterile dressing is applied from the mid-calf to the mid-thigh.

The tourniquet is not removed until the flannel bandage has been applied to produce slight compression. By this means any oozing into the joint following the removal of the tourniquet is avoided. Unquestionably hæmorrhage into the joint is responsible for much of the post-operative stiffness occasionally seen.

The same technic is used for the removal of the external cartilage.

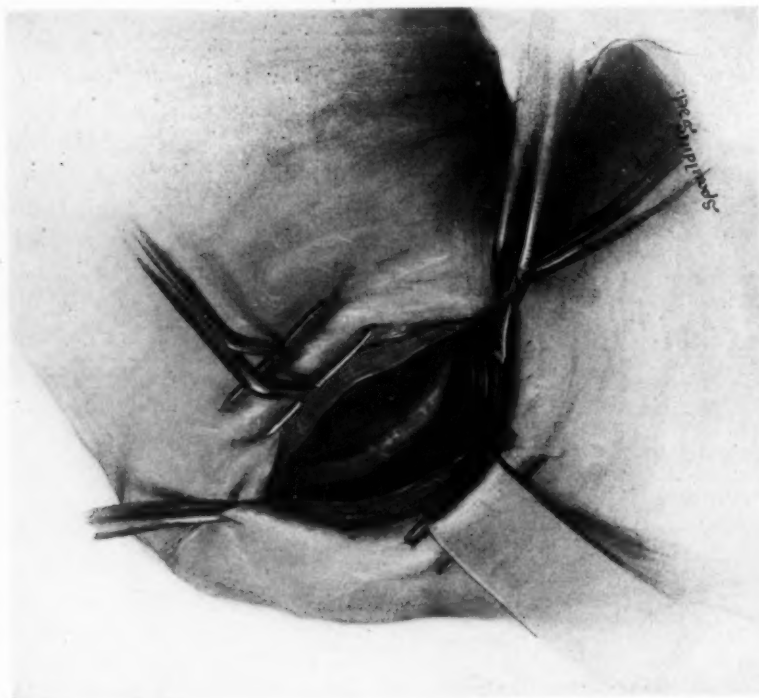


FIG. 11.—Excision of the semilunar cartilage, showing the exposure of the cartilage. The skin edges are clamped off, and the cartilage is being excised with a tenotome.

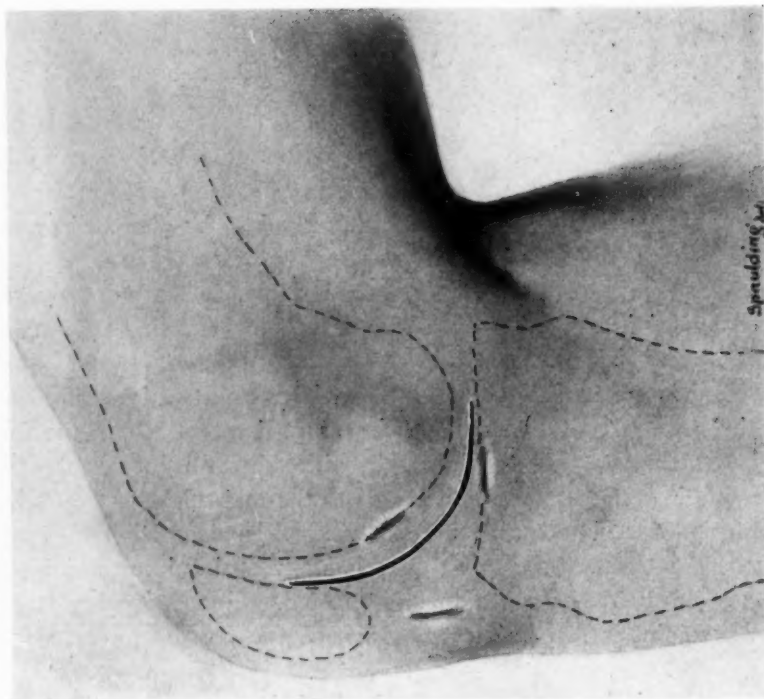


FIG. 10.—Excision of semilunar cartilage, showing depressions made by knife handle, the line of incision and the bony landmarks dotted.

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After-treatment.—In past years, it has been our custom to secure immobilization by means of a plaster bandage, which was worn for a period of two weeks. Complete immobilization has a certain advantage as far as the patient is concerned in that the pain is lessened. Of late, we are inclined to believe that this period of immobilization in a plaster bandage predisposes the formation of adhesions. To avoid this complication, we are applying a snugly fitted voluminous flannel bandage from the toes to the hip with considerable reinforcement about the knee-joint. This bandage holds the knee snugly, and by producing compression prevents any extravasation of fluid and hæmorrhage subsequent to the operation. In addition, the bandage, as it begins to loosen, allows a little freedom of motion during the first week after the operation. Our experience with this procedure thus far seems to bear out our view that it is preferable to complete post-operative immobilization.

The duration of the convalescence depends entirely upon the pathology. Recovery from a hypermobile or torn cartilage that has been treated promptly takes place within a few weeks. Arthritic cases, on the other hand, recover more slowly. In the simple case the compression bandage is worn for ten days or two weeks. As soon as the temperature is normal and the patient is comfortable, he may begin to walk with crutches. At the end of two weeks, hot fomentations and gentle active movements are carried out daily, and speed up the convalescence. In three weeks the patient should be able to bend his knee to a right angle. Massage of the thigh and calf should be instituted as early as possible. In eight weeks most patients are able to resume moderate activity. Other patients recover much sooner. I have known a juggler to return to the circus at the end of three weeks. Convalescence is likely to be slow in industrial cases, as these patients may be influenced by the fact that they are drawing compensation as long as they are disabled, and they are, therefore, loath to use their muscles from fear of pain.

Correction of a talipes valgus or a weak foot should be practised as a routine procedure, following the removal of the cartilage, in order to prevent strain on the internal lateral ligament. A lift on the inner side of the heel and sole may be used for this purpose.

AN ANALYSIS OF 388 OPERATIVE CASES

This series of 388 cases extends over a period of twenty-five years; the most recent case is dated December 31, 1929. Seven associates performed the operations.

A searching questionnaire was sent to all patients upon whom operations had been performed before July 1, 1929. No attempt was made to ascertain the post-operative results in cases in which at least five months had not elapsed since the operation. Direct replies, or information from reliable sources, were received in 287 cases. These data have, in each case, been correlated with the pre-operative findings available, as well as with the

pathology disclosed at operation. As it has not been possible to obtain a complete history of each case, our report on the different findings must, of necessity, be based upon varying statistics. A statement as to the exact number of cases recorded will, therefore, be found in each section.

Sex, Age, and Joint Involvement.—Two hundred and fifty-two cases, or 65 per cent. of the series, were males.

The age distribution, as determined from the 349 case records available, showed the average age at the time of operation to be twenty-one years. Thirty-two per cent. of the patients were between the ages of twenty-one and thirty; 23 per cent. were between eleven and twenty years; and 17 per cent. were between thirty-one and forty years of age. There were two cases younger than ten years, and there were eight cases between the ages of sixty-one and seventy.

The right and left knee were involved almost equally; in fact, in the series of 363 records obtainable, there were 181 involvements of the right knee and 182 of the left knee.

Etiology.—The etiology was found recorded in 355 of the 388 cases. In 87 per cent. trauma was the specific etiological factor. By far the majority of the injuries were of an indirect nature, including wrenches, twists, and sprains. Falls held a prominent place in the etiology. Many of the derangements were sustained during activity in sports, particularly in football and basketball. In five cases the disturbance was due to disease, tuberculosis of the knee-joint being the underlying cause in one case, and hypertrophic arthritis in four cases. In thirty-nine cases the cause was unknown; there was apparently no history of injury and no manifestation of disease. The presence of a lesion within the joint was indicated by the symptoms of pain, either of acute or slow onset, swelling, and local tenderness.

Symptoms.—The incompleteness of the pre-operative records and the fact that, during the period of twenty-five years over which this series extends, emphasis was placed on different symptoms at various times, make it impossible to compute exact statistics on the manifestations of the derangements. From approximate calculations, the most characteristic symptoms were pain, weakness, and tenderness over the site of the affected cartilage. Locking occurred in nearly one-third of the cases, and it was present in several cases at the time of operation. Many patients complained of a "sense of derangement," a "giving way," or "something slipping in the knee," and in a few cases there was an audible click. Swelling was noted in about one-fourth of the cases. Limitation of motion, lameness, and stiffness were mentioned in only a small percentage of the cases. Practically all patients had experienced recurrent attacks of disability.

The duration of the symptoms varied from a few days in six cases to more than thirty years in one case. The number of patients who had had trouble for a period of years amounted to 163, and the majority of these had suffered between one and four years. One hundred and thirty-four

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patients had had symptoms for a period varying from one to twenty months, and thirty-nine patients had been disabled from one to ten weeks.

Pathology.—The internal cartilage was involved in 276 cases, the external in thirty-eight cases, and both cartilages in the same joint in forty-seven cases. No record was made in twenty-seven cases.

The pathological findings were checked in 435 instances, which included the forty-seven cases in which both cartilages were involved. Records were found in 362 cases, but unfortunately they are brief in many instances. One hundred and forty-six cartilages, or 34 per cent. of the series, were listed as hypermobile. This percentage might have been lower if complete notes had been made, stating whether a marginal or posterior fracture existed. One hundred and forty-nine cartilages were fractured, but the site of the tear was not always designated. Nineteen were located at the anterior tip, thirteen in the anterior half, seven in the middle, and ten in the posterior half. Three cartilages were split from the anterior to the posterior end. While the bucket-handle type of fracture is mentioned in only five cases, it undoubtedly existed in many more, probably in as many as fifty cases. There were fifty cases of displaced cartilages. Five cartilages were totally avulsed. In addition, the menisci were swollen and thickened, and a few were calcified. Some cartilages were so altered that they could hardly be identified. Loose bodies, fat tabs and lipomata were excised in several cases. Hypertrophic changes were noted in several cases, findings that usually explained an unsatisfactory result. Capsular thickening was noted in some cases of long standing.

End-results.—The results have been considered from the following points of view: 1, satisfaction of the patient; 2, recurrence of the trouble; 3, limitation of movement; 4, stability; 5, comparative strength of the two knees; 6, pain and discomfort since the operation; 7, the period of convalescence; 8, traumatic or infectious involvement of any other joint since operation; and 9, occupation of the patient.

Three hundred and seventy-two questionnaires were sent out, and 287 replies were received. It was impossible to obtain information on the other cases. Inquiries were not sent to eight patients who had had operations too recently, nor to eight patients who, in view of the complications existing at the time of operation, could not possibly have obtained joints which they would consider satisfactory, although in some instances they might have secured relief from the cartilage symptoms for which the operation was performed. This latter group will be discussed farther on in the paper.

In 223 cases, one to ten years had elapsed since the operation, and in fifty-five cases, ten to twenty-five years had elapsed. In forty-one cases, there was an interval of five to ten months between the operation and the time of inquiry. Eight cases were not checked because the operation had been performed too recently. The time interval was unrecorded in sixty-one cases.

The duration of the average convalescent period was six months.

Of the 287 patients who replied to the questionnaire, 230 or 80 per cent. expressed satisfaction with the result. Twenty-eight patients stated that they were not entirely satisfied and twenty-nine were dissatisfied.

Ninety-six patients of the "satisfied" group reported that the result was perfect, and the knee normal in every way. One hundred and six patients in this group stated that they experienced slight symptoms from time to time; the leg pained slightly in inclement weather, or it tired easily or was numb, or the patient felt the need to favor it. Such symptoms were so slight as to be practically negligible. Four patients who had had the operation only five months previously complained of slight symptoms, but the prognosis in each case is excellent. There were twenty-four patients in this group who, while they expressed satisfaction with the result, complained of definite pain, instability in walking or running, limitation of motion, or weakness.

Interesting notes were made in the questionnaires by some of these patients of the "satisfied" group. Practically all of them had returned to their former occupations regardless of how strenuous they were. One patient climbs trees, carrying heavy loads; another schools ponies all day; several patients walk many miles a day without discomfort; and others are active in sports of all kinds.

The results in the cases in which definite symptoms were present, although the patient considered the outcome satisfactory, as well as the results in the questionable and unsatisfactory cases were carefully investigated. In the study of these cases it is necessary to consider whether the operation has been satisfactory not only from the point of view of the patient, but also from the surgeon's standpoint. Not infrequently, one is called upon to remove a cartilage presenting a predominance of symptoms in the presence of a coexisting disease or other pathology. In such cases operative interference cannot offer entire relief to the patient, but the cartilage symptoms are checked, a more stable knee is obtained, and often the condition of the entire joint is benefited by the removal of an aggravating factor. It is most likely that the patient in judging the outcome of the operation is unable to discern between relief from the symptoms due to the cartilage derangement and those due to the existence of other pathology, with the result that unless normal function has been obtained, he condemns the operation. There are other cases in which the after-care was neglected, or a second injury complicated the result, or the patient was influenced in replying by the fact that he had a case under litigation.

In the series of 287 cases there were thirty-four cases complicated by the presence of arthritic symptoms; some cases showed mild or severe hypertrophic changes at the time of operation; others had a generalized arthritis, existing either before the operation or developing afterward, and while the infection was not located definitely within the joint it undoubtedly had a deleterious effect upon it; and in still other cases a monoarticular arthritic joint had existed. Sixteen of these patients considered the operation satisfactory, although they still experienced symptoms of an arthritic

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nature. Fifteen patients, four of whom were only partly satisfied with the result and eleven of whom expressed dissatisfaction, upon examination, showed that the cartilage symptoms had been relieved and the joints generally improved. From the surgeon's standpoint, therefore, arthrotomy had been warranted and the results might be considered satisfactory. In the three other cases the arthritic element was so severe that it was impossible to judge the result of the cartilage operation.

There were eleven cases in which, in addition to the cartilage derangement, other pathology was present. Among these lesions were damage or weakness of the ligaments or tendons, congenital dislocation of the patella, osteochondritis of the femoral condyle, decussation, and fracture of the tibia. This fracture case was a severe one of the tuberosity of the tibia which allowed a 45 degree knock-knee and had existed for six months to a year. In the presence of such diffuse and long-standing pathology the knee could not be restored to normal, but the result in so far as the removal of the cartilage symptoms was concerned was satisfactory. Four other cases showed upon examination that they had improved sufficiently and had such a favorable prognosis that they might be considered satisfactory by the surgeon. Six patients reported that they were satisfied with the outcome.

There was still another group of cases in which the results reported by the patient as "partly satisfactory" or "unsatisfactory" proved upon examination to be satisfactory from the surgeon's point of view. In one case muscle disuse accounted for the unfavorable reply; examination showed that the result was an unusually good one and the prognosis is excellent. One patient who had suffered a great deal since the operation with ulcers of the stomach and intestine could not consider the knee condition with an open mind; examination showed the knee to be satisfactory in every way. One boy sent a "partly satisfied" reply, but his mother wrote that the result is excellent. Another result was good considering that the patient was extremely active in his position as an instructor in soccer. Another result was satisfactory in view of the fact that the symptoms had been present for twenty years before the operation. In four cases replies of "partly satisfactory" were undoubtedly given for ulterior motives, as these patients were seeking compensation from insurance companies. There were two cases in which the operations had been performed only five months previously; they have an excellent prognosis, and the patients stated that if the improvement continues they will be satisfied with the result. One patient had an excellent result and there is no explanation for his reply.

The results in six cases, after investigation, can be considered only partly satisfactory. One patient had good function, but there was some circulatory disturbance. One patient had a quadriceps paralysis, which, however, was clearing up, and, in fact, at the time of this report two-thirds of the normal power has returned. In a third case there was quadriceps weakness following the operation. In three cases the results were clinically perfect, but symptomatically not quite normal.

There were fourteen poor results inclusive of a case that became septic. Nine patients had definite recurrence of the former trouble, indicating that other pathology, such as involvement of the other cartilage, a tab, or a fringe, was present. One cannot place too much emphasis on the importance of thorough inspection of the joint at the time of operation. Some of these cases are now under observation pending a decision for a second arthrotomy, which, had thorough examination of the joint been made at the first operation, could have been avoided. Two other patients in this group complained of constant pain, the presence of which could not be explained. One patient had an unstable knee, and another had limitation of motion, instability, and pain.

It is impossible to classify six results. In one case a blood-stream infection set up two weeks following the operation, and the knee became septic. The process cleared up, leaving the joint somewhat limited in motion. The prognosis is good. One patient left the hospital against advice; another went to an osteopath for after-care; another suffered a strain of the knee two months after the operation; one had had symptoms so long that a good result could not be expected; and one joint was tuberculous.

In regard to the eight cases in which questionnaires were not sent, one patient had developed a post-operative sepsis (the only case in the entire series), one case, in which a tuberculous process was suspected at the time of operation and confirmed later by a pathological examination, developed into a tuberculous joint, and one case subsequent to operation developed into a Charcot joint with its usual course of symptoms. The advisability of operation in a possible tuberculous or syphilitic case should be considered carefully, for sufficient benefit would not be secured to warrant the arthrotomy. In the two instances cited the operation was hardly justified. There were three cases of general arthritis. One other case was complicated by a severe fracture, and another patient had an intermittent hydrops and the removal of the cartilage was merely incidental in treatment.

Summary.—After this investigation of the results, in which all the factors that might influence the outcome of the operation were considered, one may conclude that the operative results were more satisfactory than is indicated by the statistics based upon the patients' replies. Two hundred and sixty-two results, or 91 per cent. of the series of 287 cases, were satisfactory from a scientific and clinical standpoint; six cases were partly satisfactory; thirteen cases could not be classified; and fourteen results (including eight cases in which no questionnaires were sent) were poor.

CONCLUSIONS

1. The removal of a semilunar cartilage according to the technic described is followed in the majority of cases by a result entirely satisfactory to the patient.
2. The best results are obtained in cases of young adults when the offending cartilage is removed within a short time of the trauma.

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SUMMARY CHART OF CASES

No. of cases	Sex	Age	Knee involved	Cartilage involved	Etiology	Pathology	Time between onset and operation	Time since operation	End-results
388	Males 252	8-10 yrs. 2	Right 181	Internal 276	Trauma 311	Hyper-mobile 146	Days 6 cases	5-10 mos. 41 cases	<i>From patient's viewpoint</i>
	Females 136	11-20 yrs. 81	Left 182	External 38	Disease 5	Fractured 149	Weeks 39 cases	1-10 yrs. 223 cases	Satisfactory 230
		21-30 yrs. 112		Both 47	Cause unknown 39	Dislocated 50	Months 133 cases	11-25 yrs. 55 cases	Partly satisfactory 28
		31-40 yrs. 62				Totally avulsed 5	Years 164 cases		Unsatisfactory 29
		41-50 yrs. 49							Unrecorded 101
		51-60 yrs. 35							
		60-70 yrs. 8							
		Un-recorded 39	Un-recorded 26	Un-recorded 27	Un-recorded 34	Un-recorded 85	Un-recorded 46	Un-recorded 69	<i>From surgeon's viewpoint</i>
									Satisfactory 262
									Partly satisfactory 6
									Unclassified 13
									Poor 14
									Unrecorded 93

3. A guarded prognosis must be given in cases with any arthritic tendency, which include cases of long standing that show definite hypertrophic changes at operation, and cases of older patients, that is, those beyond middle life.

4. Particular attention should be given to the treatment of mild injuries. If a slightly damaged cartilage is neglected, it exposes the joint to progressive arthritic lesions.

5. The most reliable diagnostic features are: *a.* A definite history of trauma. *b.* Recurrent periods of disability with local pain, slipping, effusion, and swelling, initiated usually by some minor injury or twist. *c.* Acute local tenderness at the point of attachment of the cartilage where the damage is located, with a tendency for the tenderness to persist at this point. *d.* Locking, that is, the sudden inability to extend the joint fully. *e.* The absence of the cartilage-thrust.

6. The presence of an early pathological lesion such as tuberculosis or syphilis must be borne in mind when operation for the removal of the cartilage is advised.

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BENIGN TUMORS OF THE TENDON SHEATHS OF UNUSUAL SIZE

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THE benign tumors of the tendon sheaths, which have gone under the name of xanthosarcoma, spindle-cell sarcoma, myeloid tumor, myeloid endothelioma, myeloxanthoma, granuloma, and giant-cell sarcoma, were first reported by Von Chassaignac in 1852.¹ Heurtaux,² in 1891, was the first one to differentiate these benign tendon-sheath tumors from the sarcomas, in that they follow a definite, benign course, whereas sarcomas are malignant in character. Heurtaux named these benign growths myelomas.

Although most of the authors agree to the fact that these tumors are benign growths, there is still a difference in opinion as to their histogenesis whether they are granulomas or true neoplasms.

Arzt,³ Broders,⁴ Ely,⁵ Fleissig,⁶ Janik,⁷ and Ollernshaw⁸ conclude that these tumors are granulomatous in nature, this conclusion being based upon the assumption that the giant cells present in the tumor masses are foreign body giant cells produced by the constant irritation of the tissues by the cholesterin deposits.

Bellamy⁹ and Stewart and Flint¹⁰ believe that the tumors are endothelial in origin and that too much stress has been laid upon the finding of cholesterin deposits, regarding them possible etiological factors for this tumor growth.

Targett,¹¹ in 1897, thought these tumors to be spindle-cell sarcomas but was unable to explain the presence of the giant cells. He emphasizes, however, that "the relation of these tumors to inflammatory processes need not be discussed, since they are neither tuberculous, syphilitic, or granulomatous clinically as well as histologically."

Dor,¹² in 1898, was first to describe the xanthomatous cells in the xanthosarcoma and this led him to believe that he was dealing with a mixed tumor composed of xanthomatous and myeloid tissue. He also believed that the presence of these two types of cells was brought about by a different histological development of a common cellular element.

Tourneaux,¹³ in 1913, calls the tumors under discussion sarcomas of a low malignancy. Harbitz¹⁴ and Buxton¹⁵ regard them as benign, since they do not recur after thorough removal, nor do they form metastases. They also maintain that the tumors are mesothelial in origin.

Shattuck¹⁶ discusses the possibility that giant-cell myelomas of the tendon sheaths are the same kind of myelomas that occur at the ends of the long bones. He explains them on the basis of persistent growth of bone elements displaced, during embryonic life, into the tendon sheaths which are continuous with the bone.

Albertini,¹⁷ in his recent work upon this subject, in which he gives an exhaustive résumé of the literature, has demonstrated that in all giant-cell tumors the ground tissue exhibits the structure of mesenchyma, and the giant cells which characterize them are, like spindle cells, mesenchymal forms whose protoplasm has not undergone division. He believes that the abundant capillary network in all giant-cell tumors is formed from the mesenchymal reticulum of the ground tissue which has undergone a kind of canalization because of the blood entering it. Accordingly, if the abundance of vessels in the tumor tissue does not arise from budding, as in inflammation, the support for the

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granulomatous nature of the tumor falls to the ground. He denies that the giant cells are wasted vascular germs, but that they are intertwined with the retiform tissue, and, owing to the canalization of the retiform tissue by the blood, they undergo transformation into cells resembling endothelium and thus come to lie in the opening of the blood spaces.

Since the anatomic and clinical characteristics speak against the sarcomatous nature of these tumors, Albertini, therefore, discards both the sarcoma and granuloma hypotheses and names these growths "benign xanthomatous giant-cell tumors of the tendon sheath."

The tumors are usually relatively small. Only in a few instances do they reach such an unusual size as in the cases to be reported. The first is interesting not only because of its large size but also because of its tendency to cause atrophy of bone by pressure and to invade the bone. Through a search of the literature on the subject, I read of six cases in which the bone was



FIG. 1.—X-ray showing the extent of bone atrophy and erosion due to pressure and invasion of the tumor mass.

involved in this type of growth. One case, described by Venot,¹⁸ showed the tumor springing by two pedicles from the palmar surface of the middle and terminal phalanx, respectively, and ending up in a large tumor mass in and around the tendon sheath. This condition led Venot to consider the tumor growth as a primary osseous growth. A second case was reported by Ely⁵ in which he describes a xanthosarcoma existing in both bone and tendon sheath in the region over the lower end of the fibula.

REPORT OF CASES

CASE I.—Steve M., aged twenty-two, laborer, was admitted to the Cook County Hospital, Chicago, Illinois, August 22, 1929, with a complaint of swelling in the left foot for a period of three years. The patient stated that he was perfectly well until three years ago, when he noticed, without any apparent cause, a small nodular swelling on the lateral side of his left foot. The swelling has gradually increased in size but has never broken down nor discharged. The swelling has caused very little pain but much discomfort due to its size. The patient was a white adult male who was not acutely ill

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and presented as the essential finding a swelling in the left foot about the size of an orange. This tumor extended into the lateral three toes. The mass was immovable and had no signs of inflammation such as redness or heat. Popliteal or inguinal glands were not palpable.

The X-ray picture (Fig. 1) reveals the shaft of the metatarsal bone of the fourth toe completely destroyed or rather replaced by a new growth, and as it approaches the epiphyseal ends, bone fragments become visible. There is a marked atrophy of the first or proximal phalanx of the same toe. The third toe adjacent to the fourth toe shows pressure atrophy of the metatarsal bone and is also convexed medially. A lateral X-ray picture shows a dorsal convexity of the metatarsals due, possibly, to the force exerted by the tumor upward against the bone.

August 29, 1929, a longitudinal incision was made over the fourth metatarsal bone. The skin was reflected from the tumor mass and the mass was separated by dissection from the surrounding tissues. The fourth metatarsal bone was imbedded in the tumor



FIG. 2.—Case I. Showing extent of tumor mass with erosion and distortion of the metatarsal bone.

mass and was removed en bloc along with the fourth toe. The patient made an uneventful recovery and was discharged on September 4, 1929. He was last heard from May 28, 1930, and he states that he has not noticed any recurrences of growth.

Gross pathological description of specimen.—The specimen consists of a toe of the left foot amputated at the proximal portion of the metatarsal bone. The toe (Fig. 2) is completely replaced, except for the distal phalanx, by a grayish-white mass which is elastic and moderately firm. This mass completely envelops both the dorsum, lateral and plantar surfaces of the toe. The portion of the tumor that is bare of epidermis reveals streaked areas brown in color. These brown-streaked areas are more common on the plantar surface than on the dorsum of the foot.

On sectioning through the center of the toe, the mass is of the same grayish-white color and is streaked throughout by brown to light yellowish lines. This mass measures five and one-half centimetres vertically, eight centimetres anteroposteriorly and six and

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one-half centimetres in transverse diameter. The tumor surrounds and displaces the tendon of the extensor digitorum to a more dorsal aspect. The growths extend both below and above the metatarsal bone which is almost completely replaced by this elastic and moderately firm mass. On the dorsal aspect, especially in the distal portion, the mass grows out in a cauliflower-like fashion and covers the uninvolved distal portion of the toe for about one and one-half centimetres.

The articulation, between the proximal portion of the first phalanx and the distal portion of the metatarsal bone, is partially destroyed and replaced by a small mass of brown to brownish-gray tissue measuring ten millimetres vertically and five millimetres anteroposteriorly. Some of this brown-stained tissue has invaded the proximal phalanx for a distance of seven millimetres.

Microscopic description.—Sections of tissues studied from the periphery of the tumor mass show that the tumor is well encapsulated by a comparatively dense fibrous connective tissue capsule. From the capsule there extends into the tumor mass trabeculae of fibrous tissue. The trabeculae, in turn, spread out in a fine reticulum and act as a supporting structure to the tumor cells, which are arranged in columns or alveoli. In some areas where degeneration has taken place the connective tissue has undergone hyalinization.

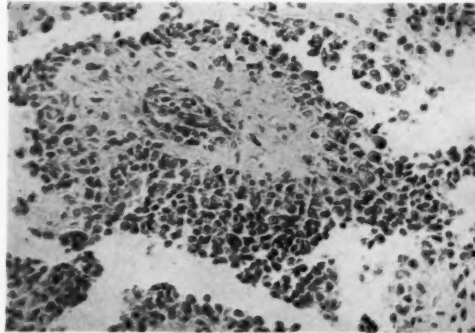


FIG. 3.—Showing the typical oval cuboidal, and polygonal tumor cells. (Mag. 380.)



FIG. 4.—Showing tendency of the tumor cells to line clefts. (Mag. 100.)

Throughout the tumor mass there is a variation in the amount of connective tissue present. In some regions the tumor cells are surrounded by large masses of connective tissue and in other regions by only very fine connective tissue strands. The fibrous capsule is well supplied by blood-vessels.

The cellular elements of the tumor consist of a type cell, as well as giant cells, lymphocytes, and pseudoxanthomatous cells.

The type cell is round, oval or cuboidal in shape with a distinct homogeneous, slightly oxyphilic cytoplasm. The nuclei are round or oval and sometimes show small indentations. There is a moderate amount of chromatin with small nucleoli (Fig. 3).

These cells lie singly and are surrounded by fibrous connective tissue. In places there is quite an abundance of intercellular material while in other places the cells tend to line irregular crevices (Fig. 4) or to form alveolar groups in which cell borders cell. The alveolar formation of these type cells occurs especially at the periphery of the tumor, whereas in the central portion near the region where the tumor surrounds and invades the bone, the cells are arranged singly or in column, each column being surrounded by a thin or thick fibrous network.

The giant cells are scanty, irregularly scattered and closely resemble osteoclasts. These giant cells contain many small nuclei, evenly distributed in an oxyphilic homogeneous cytoplasm and are found in the greatest number in places where blood pigment is most abundant especially in the interarticular polyp-like area. (Fig. 5.)

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In close topographic relation to the blood pigment deposits are groups of pseudo-xanthomatous cells. These cells have an irregular, somewhat indefinite cellular margin. The nuclei are small and granular and the cytoplasm is vacuolated. When these sections are stained with Sudan III, a great number of them are found to contain fat droplets and some of these cells contain blood pigment as well. A polariscopic examination of unstained sections revealed the presence of double refractile droplets.

Scattered throughout the tumor, especially in the periphery, are lymphocytes.

In addition to the cells just described there is found quite an abundance of dark yellow-brown pigment, particularly in places exposed to trauma (near the joint). The pigment granules are all found to be intracellular and when stained for iron with potassium ferrocyanide and hydrochloric acid give the Prussian blue reaction. In most instances the pigment granules are distributed along and about the blood-vessels. Recent hæmorrhages are also noticed.

The blood-vessels of this growth are well developed and have a definite adventitial layer. In the centre of the tumor mass close to the bone, the endothelium is quite flattened. The blood-vessels in the periphery of the tumor, however, show swollen endothelial cells. The vessels that lie in the fibrous capsule are surrounded by lymphocytes.

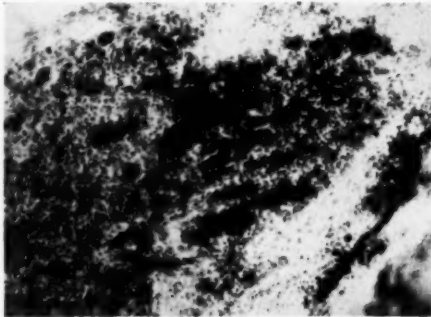


FIG. 5.—Giant cells in relation to blood pigment.
(Iron stain.)

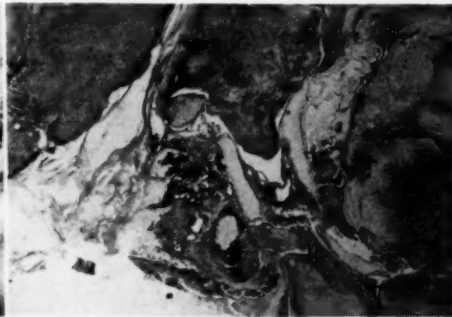


FIG. 6.—Showing invasion and destruction of the joint between the metatarsal and phalangeal bones by the tumor mass. (Mag. 8.)

The preëxistence structures such as tendon, bone and cartilage (Fig. 6) are surrounded, invaded and broken up by the tumor mass.

CASE II.—A colored female, seventy years of age, was admitted to the Cook County Hospital January 27, 1930. The tendon sheath tumor, in this case, was an incidental finding at the autopsy (performed by Dr. Philip Shapiro). The post-mortem findings in addition to the tumor mass, which shall be described later, were chiefly those of eccentric hypertrophy of the heart with severe parenchymatous degeneration of the myocardium and brown atrophy: arteriosclerosis and arteriolosclerosis of the kidneys with cloudy swelling; bronchopneumonia of both lower pulmonary lobes; chronic indurated pulmonary tuberculosis at the apex of the left lower lobe with slight bronchiectasis and a huge pedunculated fibromyoma of the fundus uteri.

The tumor of the tendon sheath consisted, grossly, of a large gelatinous, bulbous mass seven centimeters in diameter. It lay over the left first metatarsal space separating, to a fairly wide extent, the great and second toe.

Microscopic studies of sections of the tumor mass revealed it to be composed of the type cells which have been described in the first case, except that they appear to be somewhat smaller in size. These cells are arranged in cords or alveoli and are supported by a fine or heavy stroma of fibrous tissue. Sudan III stain of the tissue shows a moderate amount of fat around the larger blood-vessels of the cutaneous and subcutaneous tissue. The tumor cells themselves contain but only very minute fat droplets.

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A careful search was made for giant cells, similar to those found in the first case but without avail. Not a single one could be found. Hæmorrhagic areas or areas of cholesterin deposits were also absent.

Lymphocytes and a few plasma cells are scattered irregularly throughout the tumor mass. The capillary blood-vessels are few in number.

The tumor mass is well separated from the cutaneous and subcutaneous tissue and appears to originate from the tendon sheath. In the basal part of the tumor mass the cells definitely separate the coarse collagen trabeculæ of the tendon proper.

Discussion.—In considering the various theories offered as to the histogenesis of the so-called xanthosarcoma, we may say that the tumor is a true neoplasm of mesothelial origin and is not a granuloma for the following reasons. The tumor appears to be derived from the cells that line the tendon sheaths. There is the tendency of the tumor cells to line clefts (Fig. 4), thus imitating the physiologic arrangement of cells from which they have developed. The increase of connective tissue in the tumor mass is due possibly to a transformation of the mesothelial cells to fibroblasts. Such a condition has been very clearly shown by Maximow¹⁹ in cultures of peritoneal exudate containing mesothelial cells. By culturing the peritoneal exudate, he was able to show the transformation of the mesothelial cells into fibroblasts.

It is interesting to note that a malignant form of tumor, simulating to some extent the benign structure of the so-called xanthosarcoma, is described by L. W. Smith²⁰ as a synovioma. He describes this tumor as characterized by spaces lined in most instances by low cuboidal epithelial-like cells separated by compact cords of spindle-shaped cells which in some portions of the tumor mass are devoid of intercellular substances and fibrils. Mitotic figures are present in both types of cells. He is also of the opinion that both types of cells are derived from a common multipotential cell, since he has shown the synovial lining type and the supporting stromal type with intermediate forms of cells between these two types of cells. He also states that the tumors may arise from the synovial membrane of the joint cavity itself, of the synovial membrane of some overlying bursa, or from the fascial aponeurosis.

Harbitz¹⁴ cites tumors of the auricular capsule and synovial membrane both of which resemble xanthosarcoma. In one case it was a slow-growing tumor with subsequent recurrences upon removal and was more of a sarcomatous nature. In the second case it resembled tuberculosis clinically but histologically it was described as a xanthofibrosarcoma giganto-cellulare pigmentosum.

Albertini¹⁷ has demonstrated that the ground tissue in his benign xanthomatous giant-cell tumors of the tendon sheath exhibits the structure of mesenchyma.

Unlike McWhorter and Weeks,²¹ and others who are of the opinion that these tumors, like the multiple xanthomas, are due to systemic disturbances of the cholesterin metabolism, the deposits of cholesterin in the tumor mass are secondary to the growth of the tumor. Since the pseudoxanthomatous cells are in close topographical relation to pigment deposits of old hæmorrhages, apparently from repeated trauma, the cholesterin deposits are therefore due chiefly to the liberation of cholesterin from the degenerated blood-cells. Beneke,²² in the report of his case, which deals with a tumor of the foot developing during a course of six years following an injury in which the upper portion of the foot has broken through the skin, also believes that the cholesterin is derived from the degenerated blood, since he finds that cholesterin and hæmosiderin appear simultaneously.

LARGE TUMORS OF TENDON SHEATHS

The fact that cholesterin deposits are secondary to the growth of this tumor mass is further supported by the second case which I have reported. In no place was I able to find cholesterin polariscopically, nor was I able to find old or recent hæmorrhagic areas which would most likely liberate cholesterin to form cholesterin deposits.

In both cases reported the blood cholesterin determination was made. The first case had 147 milligrammes/100 cubic centimetres of blood. The second case had a blood cholesterin of 177 milligrammes/100 cubic centimetres of blood. Both cases then, are practically within normal limits. This finding readily removes the possibility that the tumor growth may have been due to generalized disturbance of cholesterin metabolism or a hypercholesteræmia. Gonzalez Aguilar²³ has also reported a case where, in the absence of a hypercholesteræmia, there were cholesterin lipoids and cholesterin bodies in the tumor mass.

It is shown by Stewart²⁴ that deposits of cholesterin may occur in various pathological lesions. The cholesterin deposits in the benign tumors of the tendon sheath may be placed, then, in that condition or category in which deposits of cholesterin are due principally to local tissue changes with no chance for the escape of the products of disintegration.

The presence of giant cells has caused a great deal of diverse opinions. Fleissig⁶ and others are of the opinion that these giant cells are foreign body giant cells due to the presence of extracellular cholesterin and cholesterin ester deposits. Stewart and Flint,¹⁰ on the other hand, have shown that giant cells were present in the absence of cholesterin deposits in one of the cases they have reported. They believe them to be endothelial in origin.

Mallory²⁵ states that giant cells of at least two different types occur in tumors. One type results in multiple mitosis and is a true tumor giant cell. It signifies rapid growth and may occur in a variety of tumors. The second type is due to endothelial leucocytes invading the tumor and fusing to form foreign body giant cells.

Broders⁴ believes that the function of the giant cells in this tumor mass is to absorb the foreign material present.

Albertini¹⁷ considers the giant cells to be derived from mesenchyma and to be the same as the ground cells except that their protoplasm has not undergone division.

In studying the giant cells in the first case (Fig. 5), one is impressed with the close topographical relationship existing between the giant cells and the hæmorrhagic areas. The giant cells appear to be derived from the endothelium of the blood-vessels and show early attempts to organize the hæmatoma formed by the hæmorrhage. The giant cells then may be considered as a separate entity from the typical tumor cell found in this benign growth of the tendon sheath. This last statement is supported by the studies made on the second case, reported in this paper, where, in the absence of hæmorrhage or hæmorrhagic areas, no giant cells were found.

In view of the fact that these tumor growths are neither malignant nor granulomatous in nature, it would be misleading to call them sarcomatous or granulomatous growths. Therefore, on the basis of microscopical findings, which show that giant cells and xanthomatous cells with cholesterin bodies are occasionally absent, these tumors should be named benign tumors

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of the tendon sheath. However, if the giant cells and xanthomatous cells are present, which are secondary to the actual tumor mass, they may be named under Albertini's nomenclature as "benign xanthomatous giant-cell tumors of the tendon sheath."

SUMMARY

1. Benign tendon sheath tumors are true neoplasms.
2. Cholesterin deposits are secondary to the tumor growths and are liberated by the degeneration of the red blood-corpuscles.
3. Giant cells are endothelial in origin, and attempt early organization of the hæmatoma formed by hæmorrhage into the tumor substance.

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VARICOSE VEINS: INDICATIONS AND CONTRAINDICATIONS TO INJECTIONS

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FROM THE VARICOSE VEINS CLINIC OF THE LOS ANGELES GENERAL HOSPITAL

MAJOR complications following the injection treatment of varicose veins are occurring with such frequency, that the call for a voice of warning is imperative. It is unfortunate when such cases are concealed, or divulged under the cloak of confidence. These accidents have been preventable. On the other hand, there are sufferers who are being denied treatment because of timidity based on ignorance. It is not right to deny help to patients for reasons based on prejudice; it is wrong to treat them at a serious hazard.

Buerger's disease (thromboangiitis obliterans) is frequently associated with varicose veins. There is an increase not only in the recognition of cases, but an actual increase in the number of cases occurring. It is an absolute contraindication to the injection treatment. It is easy to see the varicose veins and fail to recognize the early stages of an underlying thromboangiitis obliterans.

Dr. Leo Buerger reports to me a moderately early case of Buerger's disease in which injections of the varicose veins, performed by another physician, were followed at once by gangrene of both legs up into the thigh, necessitating bilateral high amputation!

Preliminary examination must not only include inquiry as to intermittent claudication, but also determine whether there is pulsation in the artery dorsalis pedis and artery tibialis posterior. In doubtful cases Samuels' test should be made, wherein the leg is elevated to an angle of forty-five degrees, and the ankle alternately flexed and extended while blanching of the plantar surface of the foot and pain in the calf are ascertained.¹

Elderly Patients.—Elderly patients are a large group. Men over sixty-five years of age comprise one out of every five male patients entering the clinic at the Los Angeles General Hospital, and one out of every ten of the total number of patients. They contribute the largest number of patients rejected. A vigorous elderly patient in good health may have his varicose veins injected but when to the senility is added some other serious handicap, danger is encountered.

Such an added handicap is senile arteriosclerosis of the legs—evidenced by lack of pulsation in the artery dorsalis pedis and the artery tibialis posterior—that I am strongly opposed to injection of the varicose veins of such patients. In many of these the pain is not due to the veins which are before their eyes, but to the arterial disease which they cannot see. I have had such patients tell me that they must have relief and found on further questioning that the pain was largely in the limb in which there were few,

if any, varicose veins. In the limb with serious varicose veins there may be no pain at all. To occlude the vein in the presence of a gradual occlusion of the artery, is an entirely different story from ligation of the vein in the presence of a sudden occlusion of the artery. The logic and results of occlusion of the vein in the presence of gradual, not sudden, occlusion of the arteries, has been discussed unfavorably by Brooks² and by Lipschutz.³ Aged folk, if their pain is due to the vein, can usually wear a linen-mesh bandage and be comfortable. Often there is impending gangrene of the feet. If gangrene, or phlebitis, or embolism follows treatment, the injection will be blamed.

Mr. F., aged sixty-eight, seen in consultation, had large varicose veins in both legs, containing small thrombotic and calcareous masses. He had severe pyorrhœa so that pus exuded from the gums on the slightest pressure. I refused to countenance the injection treatment of this patient. Two days later he developed a violent acute phlebitis with hyperpyrexia, and, for days, death seemed imminent. If his veins had been traumatized by injection, I believe a fatality would have been inevitable with death laid to the door of the injection treatment. As it was, he recovered, and as frequently happens in this particular type of case, the phlebitis obliterated the varicose veins.

Mrs. B., aged sixty-eight, a patient of Dr. I. W. Lynn, had very large varicose veins of the right leg. The artery dorsalis pedis and artery tibialis posterior had no pulsation. When pressure with the finger on the foot was released, color returned at the site of pressure slowly. There was no other apparent abnormality. Doctor Lynn refused to inject the veins. Just eight days later this patient who had not been injected was seized with a sudden pain in the leg. The great saphenous vein became thrombosed to the upper third of the thigh. The leg turned blue to the knee. Cyanosis deepened. There was no fever but a rapid pulse. Gangrene developed, necessitating high amputation.

Let the reader examine some of these cases with high amputation before his eyes, before he decides he is willing to inject the veins of the patient with absent pulsation in the artery dorsalis pedis and artery tibialis posterior.

I admit that Delater, Jentzer, Paul Linser, and Meisen sometimes allow injection even if there is senile arteriosclerosis in the legs. Reichert⁴ has advocated injection for such cases. Delater reports cases to me in which the spasm was relieved by injecting the veins, adding that the effort is futile if the endarteritis is obliterating.

On the other hand, Forestier and Gaugier agree that senile arteriosclerosis of the leg is an absolute contraindication.

Simple debility added to old age may constitute a contraindication. Linser's only fatality was in such a case.⁵ Other factors, added to old age, contraindicating injection, may be diabetes or a very high blood-pressure, a history of embolism or thrombosis in coronary or cerebral arteries, or severe focal infection.

Distant Foci of Infection.—I have previously warned⁵ that phlebitis may be of metastatic origin from infection, acute or chronic, in the pharynx or mouth, and favored the removal of chronically infected tonsils and root abscesses under devital teeth, before injection, lest infection from them,

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carried in the blood-stream, set up a phlebitis in veins, traumatized by injection. However, a more liberal position is justified. I was influenced by Gaugier who wrote me two years ago: "After making 300,000 injections we do not believe that infection of the teeth, tonsils, etc., could constitute a contraindication to the sclerosing method. We pay no attention to them." Clinical experience has forced me to Gaugier's position. I have had two cases of phlebitis following injection in which, so far as could be determined, there was no focus of infection. On the other hand, in about four thousand injections in patients who did have foci of infection which were not removed, not a single case of phlebitis developed.

Where there is a past history of phlebitis, not otherwise explained, where there are symptoms of toxic absorption such as rheumatic pain, when the patient is weak or aged—it may be safe to insist upon the elimination of such foci of infection. In other cases their removal is advised but not required. Veins should not be injected while the extraction of teeth is in progress, because at such times when the lymphatic spaces are being torn open there is unusual likelihood of absorption and dissemination of bacteria in the blood-stream. Varicose veins should not be injected in the presence of a subacute pelvic infection, or when the patient has a cold or an acute pharyngitis.

A Past History of Phlebitis.—Varicose veins patients with a past history of phlebitis are a large group, comprising one out of every six women and one out of every eight men in my clinic. These patients have veins which cause unusual suffering. I have had a patient declare that he preferred amputation to the continuance of his suffering from varicose veins which followed phlebitis. Should such patients be treated or turned away?

I must answer that each case is an individual problem in surgical judgment. The problem for judgment is not concerned with the question of the patency of the deep veins. That question, while important, is a mechanical problem which must be settled by tests which have been described.⁶ The problem for judgment is this: In the individual case, will injection stir up the old phlebitis? This danger merits prolonged thought and study. Mortality from acute phlebitis may run as high as 8 per cent.⁶ Even when the phlebitis has been in the superficial veins there may be danger. Hanschell writes me of three cases of recent superficial phlebitis which he injected in which "the resulting phlebitis and periphlebitis was unusually severe and persisted from eighteen months to two years." He who is too indolent to study the principles which I must explain further at some length, should not accept the very heavy responsibility presented by such patients.

How frequently such patients may be accepted and how frequently rejected may be suggested by some case series. I have asked Delater, of Paris, to contribute his results, for he has, I believe, the widest experience in this particular type of case of any worker living. In his series of 131 cases observed there were:

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Patients with a past history of deep phlebitis.....	79
Patients with a past history of superficial phlebitis.....	52
	<hr/>
Patients accepted for injection.....	131
Patients rejected as unsafe.....	96
	<hr/>
	35
	<hr/>
	131

Of the seventy-nine with a past history of deep phlebitis: Patients accepted, forty-four; patients rejected, thirty-five. Of the thirty-five declined, twenty-four had signs of impaired deep circulation. All of the fifty-two cases where the phlebitis had been superficial were treated. All of those treated were cured.

I have a smaller series of forty patients with a past history of phlebitis. Of these there were treated (and with success), twenty-two; rejected, eighteen. Nearly all of my patients had had a deep phlebitis previously.

In deciding whether the patient who has had phlebitis should be taken or rejected, there are four criteria which should enter into the judgment: (1) The time interval since the phlebitis; (2) The question as to whether the phlebitis reached the deep veins; (3) The age of the patient; (4) The possibility of special treatment.

What lapse of time should be allowed after an acute phlebitis before injections are made? The only rule that can be laid down is this: The longer the interval, the less the danger.

Noel Scott⁷ waits three months after all inflammation has disappeared. Douthwaite, R. T. Payne,⁸ de Takats⁹ and J. M. Hayes¹⁰ wait six months. Delater and Troisier wait two years. Hanschell now waits three years. Forestier, previously quoted as waiting ten years, now waits only five years. Gaugier adheres to the position which he took with Sicard, and if the deep veins were involved in a deep phlebitis, advises rejection of the patient even after ten to twenty years, and holds that it may be better for the general practitioner to let them alone entirely. In my opinion, no one should be injected in less than six months after a phlebitis and sometimes I reject patients even after ten years.

The second criterion which distinguishes between a previous superficial phlebitis and a previous deep phlebitis is stressed by Delater, Douthwaite and Gaugier. They hold that there is little or no danger after a superficial phlebitis, but that caution must be used when there has been a deep phlebitis. Payne will never inject when there has been a history of phlegmasia alba dolens. Ronald Thornhill is of the same persuasion.

But how is one to tell now whether a phlebitis in the past did or did not include the deep veins? Tests for the patency of the deep veins now do not tell whether there has been a phlebitis in the deep veins in the past, because some of the deep veins may be shown by patency tests to be open

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while other deep veins may be occluded and harbor bacteria. Deep veins once thrombosed by infection may be recanalized and now be patent.

The following items do give warning that a previous phlebitis was deep: A history of surgical trauma in the lower abdomen before the phlebitis (Delater); trouble in walking for two months after phlebitis (Delater); past recurrences of the phlebitis (Delater); œdema one-third of the way up the leg (Douthwaite); a white œdema (Gaugier); hydro-arthritis of the knee (Gaugier).

In a superficial phlebitis, the inflammation is localized at the painful area, the recovery is rapid, and if there is a remaining œdema of the lower leg it disappears after application of an Unna's paste bandage (Delater).*

Forestier dissents. He minimizes the importance of the distinction between a previous superficial phlebitis and a deep phlebitis; so do Meisen and McPheeters.¹¹

Both parties in this controversy have truth behind them: Happy results from injection by careful men are being obtained in cases where the previous phlebitis was deep. Nevertheless, special caution in treatment, to be described below, is essential when there has been a history of deep phlebitis.

A third criterion which I consider important is the age of the patient. A young patient with a history of phlebitis may be accepted while an elderly patient is refused because younger patients have better resistance to infection and are not such likely subjects for thrombosis and embolism.

Special Treatment in Patients with a Past History of Phlebitis.—Some of the patients who have had phlebitis demand very different treatment from ordinary cases. In such cases instead of the usual ambulatory treatment, some of these patients are hospitalized and ordered to stay in bed. This is simply the old surgical principle of preventing the dissemination of infection by putting the part to rest. The veins are further splinted by the application of a firm linen-mesh bandage all the way up the leg, which is worn day and night. These patients require only one-tenth as large doses as ordinary patients. One or two minims of the quinine urethane solution is used as the first dose. After injection they suffer pain, not experienced by other patients, but this pain is relieved at once as long as the leg is kept bandaged.

Conclusion.—For the protection of the patient, it is recommended that before any injection treatments there be a complete physical examination or that as a minimum the following items of history and physical examination be ascertained:

* Deutsch, H., maintains that a deep phlebitis always begins with a sudden pain in the calf muscles—Zur behandlung der akuten lokalisierten phlebitis der unteren extremität, Wien. klin. Wchnschr., vol. xlii, p. 1162, September 5, 1929. Ipsen, J., notes that a thermometer on the plantar surface of the foot shows fever in a deep phlebitis but no fever in a superficial phlebitis—Recherches sur les artères à l'état pathologique, Acta chir. Scand, vol. lxxv, p. 341, 1929.

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<i>History</i>	<i>Physical Examination</i>
Name	Temperature..... Pulse.....
Address	Blood-pressure
Age	Do veins extend above the inguinal region on the abdomen.....
Age when varicose veins began.....	Edema of leg.....
Pain.....For how long	Pulsation of artery dorsalis pedis.....
Inflammation in leg.....	of tibialis posterior.....
Phlebitis or milk leg.....	Cyanosis or rubor when foot is dependent
When	Pain or blanching of toes when leg is elevated and ankle is alternately flexed and extended
Typhoid..... When.....	Sclerosis in veins.....
Pelvic troubles.....	Pain on walking five minutes with legs firmly bandaged.....
Intermittent claudication.....	Description of veins.....
Has patient ever taken quinine with symptoms of toxæmia.....	Pelvic tumors.....
	Pelvic Infection.....
Urine: Specific gravity.....	albumen..... sugar.....

In this study I am especially indebted to the following workers who have generously contributed material, largely unpublished: *Paul Linser*, of Tubingen; *Nobl*, of Vienna; *Jentzer*, of Geneva; *Aage Berntsen*, and *V. Meisen*, of Copenhagen; *Delater*, *Forestier*, *Gaugier*, and *Troisier*, of Paris; *Douthwaite*, *Hanschell*, and *Treves-Barbour*, of London; *Leo Buerger*, of Los Angeles.

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SOLUTION OF DEXTROSE AND SODIUM CHLORIDE FOR OBLITERATING VARICOSE VEINS*

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EIGHTEEN months have now elapsed since we began the injection treatment of varicose veins at the Johns Hopkins Hospital out-patient department and 464 cases have been completed. Since the publication of our original article,¹ some changes have been made in technic and sufficient time has elapsed to allow us to make a fair estimate of the worth of this form of



FIG. 1.—Showing the appearance of the abdominal wall of a dog one week after the subcutaneous injection of 6 cubic centimetres of a solution of equal parts of 50 per cent. dextrose and 30 per cent. sodium chloride in the area marked "2", and two weeks after the injection of the same amount of solution in area marked "1." Two distinct hard masses were palpable. Skin is intact.

treatment. Furthermore, there are several points in our first article which we feel require greater emphasis and some explanation.

Experimental.—Concomitantly with our clinical work we began a series of injections into the external jugular veins of dogs.¹

The vessels were thrombosed with solutions of sodium chloride 20 to 30 per cent.: sodium chloride 30 per cent. plus equal parts of dextrose 50 per cent.; sodium salicylate 20 per cent. Specimens of the injected veins were removed forty-eight hours, seventy-two hours, one week, two weeks, and four weeks following injections and microscopic studies made. The forty-eight-hour specimens showed a large thrombus obliterating the

* This investigation has been carried out in the Division of Plastic Surgery in the Johns Hopkins Hospital and in the Hunterian Laboratory.

lumen of the vein and a complete destruction of the endothelial lining. There was a leucocytic infiltration of the media and adventitia. At the end of a week all signs of acute inflammation had disappeared and there was definite evidence of beginning organization of the thrombus. Organization of the thrombus was progressive and almost complete at the end of four weeks. The smooth muscle of the media coat of the vein had been replaced, in part, by fibrous tissue. The external jugular veins of twenty-eight dogs were used for experimental purposes and in spite of the fact that thrombi were formed in veins very close to the heart, with a swift blood-current and considerable negative pressure there was in no case evidence of migration of the thrombus.

History and examination of patient.—A careful vascular history and examination should precede the injection treatment of each case. For this purpose we devised a simple chart¹ which upon completion gives sufficient data to determine in the majority of cases whether the individual is a fit

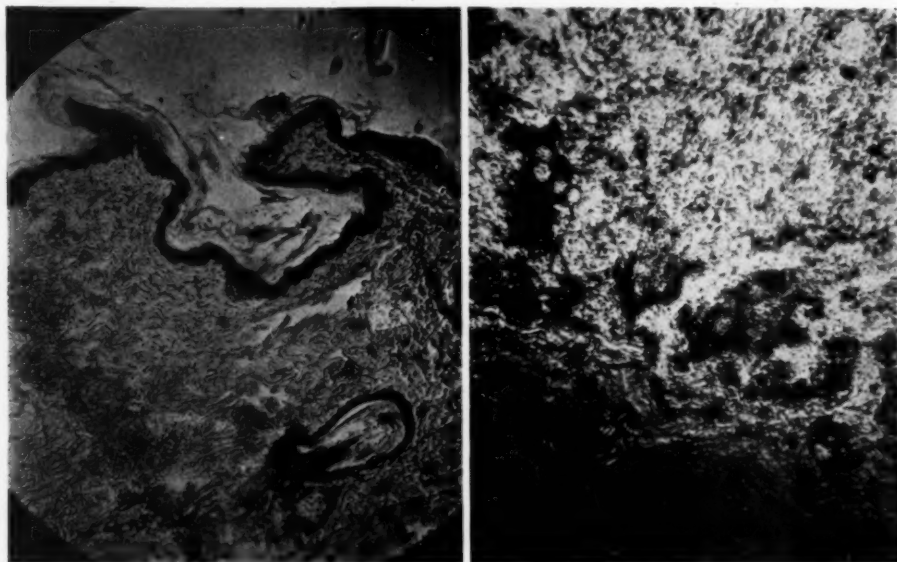


FIG. 2.—Low power photomicrographs of sections of skin and subcutaneous tissue taken from area marked "I" in FIG. 1. The skin and subcutaneous tissue show marked oedema but no cellular destruction. There is tremendous leucocytic infiltration in the fat.

subject for this treatment. We have adhered strictly to this outline and feel that it has saved us from having any serious untoward results.

History.—The duration, etiology, progress and symptoms of the varicosities are determined.

A general medical examination is made in special cases. It is usually indicated by the patient's age or certain findings in the regional examination which make one suspicious of some organic disease either associated with or a causative factor of the varicosities. If such is the case, injection is contra-indicated. If in the examination of the varicosities active or latent phlebitis is evidenced by the presence of thrombosed segments or tenderness, one should wait at least a year before giving injections.

Perhaps the most important contra-indication is obstruction to the deep

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veins. This is determined from the history and is suggested by the presence of œdema and a thickened shiny tight skin. We do not feel that there is any absolute test for determining the degree of patency of the deep veins once they have been thrombosed, and in many cases are convinced that where there has apparently occurred complete restoration of function any interference would upset the circulatory balance. Only in the presence of an ulcer which will not heal by supportive measures is one justified in obliterating the superficial varicosities. The absence of arterial pulsations in the extremities, due to arteriosclerosis, Beurger's or Raynaud's disease further contra-indicates treatment.

It is our feeling that better results will be obtained if the veins of pregnant

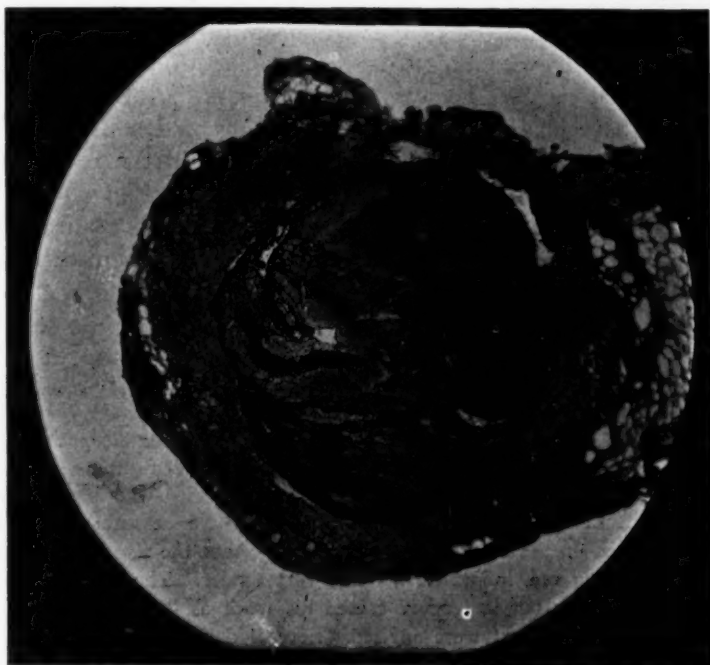


FIG. 3.—Cross-section of external jugular vein of dog, removed seventy-two hours after injection with $7\frac{1}{2}$ minims (0.45 cubic centimetres) of 50 per cent. dextrose and 30 per cent. sodium chloride, equal parts, seen under low power. Section shows entire vein occluded by a firm thrombus. The endothelium is not visible. Media and adventitia show slight inflammatory reaction as evidenced by leukocytic infiltration and dilatation of the vasa vasorum.

women are injected several months after delivery. Only in the presence of an ulcer is treatment given during pregnancy.

Solutions.—With the increasing popularity of this relatively new treatment of varicose veins the number of individuals doing injections has also increased. The solutions used by operators are more or less determined by the convenience with which they can be obtained.

In the early days of our clinic we sought a solution which would be non-toxic, effectual in the majority of cases with a minimum amount of reaction (*i.e.*, cramp) and one which would not cause a slough if a moderate

amount were injected outside of the vein. Experimentally we found that a mixture of equal parts of 50 per cent. dextrose and 30 per cent. sodium chloride made an ideal solution. (One hundred cubic centimetres of such a mixture contains twenty-five grams of dextrose and fifteen grams of sodium chloride.) When injected into the abdominal wall of a dog, intradermally (in amounts up to one cubic centimetre) subcutaneously or intramuscularly (in amounts up to six cubic centimetres) no slough resulted. However, there was a marked inflammatory reaction which could be lessened if active massage was instituted over the area immediately after injection. Experimentally and clinically the solution causes an endophlebitis equal to that of the salt solution alone and the resulting thrombus is exceedingly firm.

In the course of doing human injections a careful operator could hardly deposit more than a few drops of the solution in the skin or six cubic centimetres subcutaneously without seeing the swelling of the tissues or being notified by the patient that he was having pain or burning at the site of injection. We have inadvertently injected varying amounts of this solution outside of the vessel wall no less than 100 times in the course of 2500 injections. Just how much of the solution has been injected into the tissues at any one time we have no way of estimating because we always stopped the injection the moment a patient complained, but in our hands this mixture has never caused a slough comparable in any manner to those we have seen resulting from the use of sodium chloride, sodium salicylate or quinine. In this respect there were but two accidents following the use of dextrose-sodium chloride solution which we feel should be reported.

In one case a faulty injection of ten cubic centimetres of solution was made on the inner aspect of the knee-joint by an inexperienced worker. The patient complained of severe pain and burning and the area was actively massaged. After about thirty minutes the patient left the clinic. Forty-eight hours later when he returned for observation there was a mass on the inner aspect of the knee about the size of a small saucer, the tissues were flaming red, indurated, hot and very tender. The patient said that he had had considerable pain but had never ceased his work as "setter up" in a bowling alley. Hot compresses and rest were advised. Several days later a thin sero-purulent discharge appeared at the site of the needle puncture. With a sharp pointed applicator this tiny opening was dilated to permit freer drainage. The skin did not slough, and the inflammation subsided completely in about three weeks' time. We are of the opinion that in this case almost the entire ten cubic centimetres of solution was injected into the tissues and that fat necrosis followed.

The other accident occurred in a varix the overlying skin of which was so thin that the vein was on the point of rupture. The varix was injected and well thrombosed on the next visit of the patient to the clinic. Six days later the skin ruptured and the thrombus was extruded. No hæmorrhage occurred. The exposed vessel was curretted and the wound granulated. Healing was complete in four weeks.

The cramp following the injection of dextrose-salt solution is much less severe than that following sodium chloride alone or sodium salicylate and about the same as that following 75 per cent. invertose. Benzyl alcohol (1.5 grams to 100 cubic centimetres) added to the mixture of dextrose and

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salt solution acts as a preservative and diminishes the cramp by virtue of its anaesthetic property.

The action of the solution is rapid and the thrombosed vessels can often be palpated within four to five minutes following injection. With the exception of four cases we have not had to resort to other solutions in order to produce thrombosis. In these cases quinine hydrochloride plus ethyl urethane was used with rapid results. However, these patients complained of pain and tenderness in the legs for many weeks. Fifty injections were made with 75 per cent. invertose. Its use was discontinued following two very severe reactions. In both instances the symptoms were identical. About three minutes after the injection of eight cubic centimetres of this solution the patient complained of excruciating pain across the sacrum, pain down the arms, and a general peculiar feeling all over the body. In one instance the pain across the back was so severe that the patient was unable to move and had to lie in a semi-prone position for about ten minutes. However there were no after effects.

We have endeavored to use 50 per cent. glucose alone with tourniquets and vein occluders but our results have not been satisfactory.

Preparation of dextrose-sodium chloride.—The 50 per cent. dextrose and 30 per cent. salt solutions may be prepared in separate flasks and autoclaved for twenty minutes under twenty pounds pressure. This method of sterilization often results in carmelization of the dextrose. It is perhaps better to boil the solutions over a very low flame or water bath for ten minutes.

At the time of use the two solutions may be mixed in any desired proportion. For the general run of cases the mixture of equal parts has proven satisfactory. However in very thin-walled vessels and telangiectasis two parts of glucose may be added to one part of salt. The solutions should be very thoroughly and carefully mixed before filling the syringe in order that the buffer action of glucose may be obtained. If this is not done the chances for a slough are accentuated if a faulty injection is done. To insure thorough mixing it is our custom to measure equal parts of the solutions in a graduated medicine glass and with the syringe aspirate and eject the solution with force several times just before use.

Dosage.—The amount varies from one to ten cubic centimetres depending on the varix to be injected and also on the individual patient. It is advisable that a single initial injection be given in any case and that the dose be small in order that the patient's reaction may be determined. It is our routine to inject no more than ten cubic centimetres in a single varix and not over twenty cubic centimetres at one sitting. However, we recently learned that one investigator injected seventeen varices with eighty-four cubic centimetres of this solution at one time without any untoward results. This may be a perfectly safe procedure but we doubt its wisdom.

If the dosage is properly graduated the thrombosed veins are only slightly tender and the patient suffers no discomfort. Rarely do we see a periphlebitis and when it does occur it is usually in very fair-skinned people.

It has been our observation that the vessels in patients of the brunette type and the negro are more resistant to sclerosing solutions.

Technic.—A twenty-six guage, five-eighths inch, short bevel needle can be used for all sized varices. This type needle permits a very little spring and can be inserted with practically no discomfort to the patient. The ordinary five or ten cubic centimetres glass syringe is easier to handle than the lock syringe.

Site of injection.—As a general rule the injection is usually begun distally and successive injections made higher up according to the manner in which the vessels thrombose. As we stated before,¹ in those cases which there



FIG. 4.—Illustrating a case of marked varicosities above and below the knee of both legs before and after treatment of twenty injections of a mixture of equal parts of 50 per cent. dextrose and 30 per cent. sodium chloride were given. Treatment not completed. A—taken March 22, 1930. B—taken April 24, 1930.

are varices above and below the knee an attempt is made to block the main channel just below the knee. After this is accomplished the varices distally situated respond more quickly to treatment. We are convinced that the entire affected venous tree must be injected and obliterated to prevent the formation of new varices or the opening up of those previously obliterated. We have thrombosed vessels in the upper third of the thigh without untoward results.

In those cases where there are varices present below the knee, and the internal saphenous vein is not varicose but dilated, and stands out like a whip

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cord from the fossa ovalis down to the knee, we feel that the injection treatment should follow the ligation, and resection of a portion of this vessel in the upper third of the thigh.² This is distinctly a hospital procedure and the patient should be confined to bed for no less than three days following the operation. This procedure will help to prevent the recanalization of the thrombosed vessels as well as the formation of new varices.

Procedure.—It has been rather well established that the horizontal position of the leg is one of choice both for the patient and the operator during the injection.

While the patient is in the standing position the varices to be injected are traced out on the skin with mercurochrome.³ The ordinary toothpick applicator is used for this purpose. The patient is then asked to lie down and tourniquets are applied two to three inches below and above the proposed

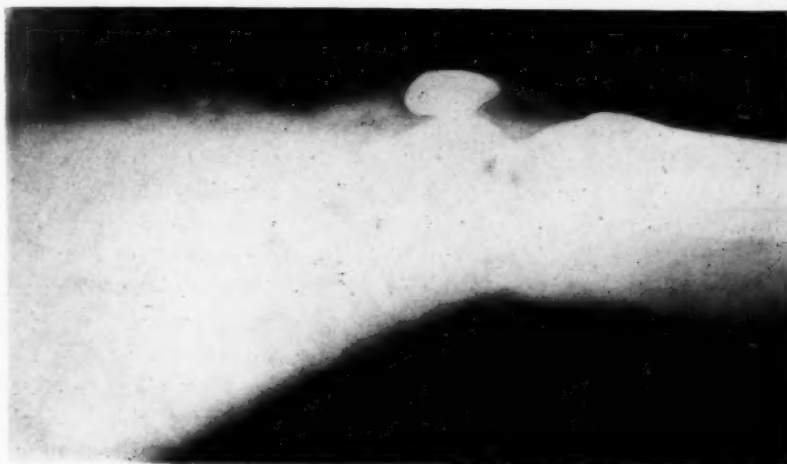


FIG. 5.—Plain X-ray, lateral view of left leg in FIG. 4 taken after large vessels above and at the knee had been thrombosed. The rather dense shadows cast by the thrombosed veins are plainly seen, thus illustrating the firm dense thrombus resulting from the injection of the mixture of sodium chloride and glucose.

site of injection. If the varix to be injected is very large the leg is first elevated above the patient's head to drain the varix of blood before the tourniquets are applied. The vessels are now in a collapsed state and the operator can be sure that the injected solution will have an opportunity to come into intimate contact with the vessel-wall. The injection area is then cleaned with alcohol and the injection slowly and carefully made. Alternately aspirating a few drops of blood with each one or two cubic centimetres of fluid injected.

The tourniquets are allowed to remain on for three to five minutes following injection during which time the varix is gently stroked to distribute the solution. Leakage will seldom occur from the puncture wound. However it is perhaps safer to make pressure with a gauze pledget and adhesive strap. The patients are allowed to rest in the prone position for five to ten minutes longer. A full-length pressure bandage is then applied to the leg

and worn by the patient continuously during treatment and for three weeks after the last injection. This reduces the size of the thrombus, insures support to the thrombosed and inflamed veins during the period of organization and minimizes the chances of canalization. Furthermore, the bandage greatly adds to the comfort of the patient during this period. The success of an injection depends upon the operator's ability to bring the irritating solution diluted with a minimum amount of blood into contact with the vessel-wall, and hold it within a limited area for a long enough time to destroy the endothelial cells. If these two conditions can be satisfied a very weak solution like 50 per cent. glucose alone may be used, if they cannot the more irritating solutions whose action is more rapid must be resorted to. This is often demonstrated in the same patient, as the large tortuous vessels with thickened walls will respond immediately to injection because the blood-current is sluggish and can be controlled, whereas the smaller thin-walled veins require many injections of the same solution because the current is swift and cannot be controlled with tourniquets or vein occluders, and the solution is washed away into the general circulation before it has opportunity to act.

Complications.—Immediately following the use of 30 per cent. sodium chloride alone there were three superficial ulcerations due to leakage from the needle hole and three patients developed an ascending chemical phlebitis with thrombosis of the internal saphenous vein up to the sapheno femoral opening. These complications occurred in the very early days of the clinic and we have since abandoned the use of sodium chloride alone. There were two severe reactions after the injection of 75 per cent. invertose which were reported in detail above. Although only four patients were given supplementary injections of 10 per cent. quinine solution they all complained of severe pain in the thrombosed vessels forty-eight hours later and almost continuous discomfort in the legs for about four weeks in spite of all palliative measures. Following the use of the mixture of glucose and salt solution which we have employed almost exclusively in the treatment of 400 cases, there were but two local accidents; one, as previously mentioned, a very severe inflammatory reaction following the injection of a large amount (ten cubic centimetres) of solution into the tissues, and the other, a rupture of a very thin-walled varix. Five patients had a marked periphlebitis following the injection of too much solution in a single varix. This condition occurred in each instance on the thigh and cleared up in about two weeks' time. One patient developed an infectious phlebitis in a varix thrombosed two months previously. On examination the varix was red, very tender and hard. Cold applications were applied and the inflammation promptly subsided. Brownish pigmentation of the skin rarely occurs following the use of this solution. There has been no case of embolism.

Results.—As is true with any surgical procedure, the results will not be perfectly satisfactory in every case. In our experience patients with the most marked varicosities and definite symptoms are those who receive the most satisfactory results. Even after the first few injections they are relieved of cramps in the legs and the accompanying heavy, tired feeling.

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Quite often there is a history of marked pain in the varicosities of the leg during the first few days of menstruation, at times so severe as to compel the individual to stay in bed. The majority of patients with this symptom have been cured, although a small percentage are unrelieved even though all visible and palpable varicosities have been obliterated.

Perhaps the most trying cases are those patients who have no symptoms and desire treatment for cosmetic reasons only. No matter what the previous condition of the legs might have been and how good the result may be as far as obliteration is concerned they are rarely entirely satisfied.

The cases complicated by ulcer formation have responded promptly and satisfactorily to treatment where it has been possible to thrombose the offending varix. Of twenty-one such cases treated but two have had recurrences. One developed a fresh ulcer eight months after treatment, and the other had a recurrence in the same place ten months after treatment with recurrence of the varices.

The treatment of eczemas has not been so satisfactory. About 50 per cent. of these have been cured, the remainder have been improved.

Recurrences.—Patients are routinely requested to wear bandages for three weeks following the last injection, then to go without support for one week and report for observation. It is frequently found necessary to obliterate one or two small varices which have enlarged or were obscured by the tight bandages. The patients are then requested to return two months later for further observation. Very few of the clinic patients have returned at this time, and those that did had a reopening of the obliterated varices. We can only conclude that those patients who did not return have received satisfactory results.

We have classified as recurrences those cases which did not receive a permanent obliteration of the injected veins following the one-month period. Sufficient time has not elapsed to determine whether these patients will develop new varices.

One hundred cases have been accurately followed, the oldest cure being eighteen months and the youngest six months. In this group there were ten patients who returned for further treatment and are considered recurrences (10 per cent.). They all occurred within the first four months after treatment, several after six weeks. In as much as the great majority of the obliterated vessels has been converted into scar tissue and almost completely absorbed in six months' time, we believe one can safely conclude that reopening will seldom occur after this period.

Six of the recurrences were only partial and only a few injections were required to re-obliterate the varices. Strange to say these patients had rather small isolated varices confined to the leg. In four cases recurrence was almost complete. Of these patients one had four small varicosities below the knee, while three had tremendous varicosities both above and below the knee. The varicosities below the knee remained obliterated while those above recurred. We are of the opinion that the recurrences in seven of these cases were due to incomplete thrombosis, and that the lumina of the veins were

at no time completely obliterated but were occupied by mural thrombi. Very often in our experimental work injected veins were removed and found to be incompletely thrombosed due to the fact that there had been only partial destruction of the intima. For this reason we gently massage the vessels after injection in an attempt to bring the solution into contact with the entire vessel-wall. In three of the cases where the varicosities were on the thigh, no doubt canalization of the thrombi occurred from the back pressure of the heavy column of blood. This was clearly illustrated in the case of a young woman thirty-two years of age who became pregnant one month following discharge. She stated that the veins began to grow prominent again about the third month of pregnancy and became steadily worse. She returned for treatment and the veins have been re-injected and thrombosed without difficulty. Were it possible to devise some tight support that could be worn on the thigh for several months following obliteration of the varices until the thrombi had become completely organized the chances of canalization would be greatly diminished. Constant application of adhesive straps is not well borne by the skin and elastic stockings are expensive and not entirely satisfactory. Whether resection of a portion of the internal saphenous in the middle third of the thigh will prevent this recurrence is yet to be determined and the procedure is not without considerable danger of embolism.

SUMMARY

1. Experimental injections of solutions were made into the external jugular veins of twenty-eight dogs. In no case was there migration of the resulting thrombus.
2. A brief outline of the history and physical examination of varicose vein patients is given together with the contra-indications to injection treatment.
3. The mixture of 50 per cent. dextrose and 30 per cent. sodium chloride as an injection solution is discussed. A detailed report of the preparation, mixing dosage, and technic of injecting the solution is made.
4. Four hundred and sixty-four cases have been completed in which dextrose sodium chloride solution was used almost exclusively. There were but two complications of any consequence following the injection of this solution.
5. A careful follow-up in 100 cases shows a 10 per cent. recurrence of the old varices, in 7 per cent. of the cases the recurrence was partial; in 3 per cent. almost complete. Recurrences are early and are believed to be due to incomplete thrombosis in the majority of cases.

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THE RELATION OF CALCIUM TO THE HÆMORRHAGIC TENDENCY IN OBSTRUCTIVE JAUNDICE

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THE hæmorrhagic tendency complicating certain cases of obstructive jaundice has long been recognized. For the past twenty years, this bleeding tendency has been considered by most authorities to be related closely with the availability of calcium in the blood-stream for the production of clot formation. The exact mechanism, however, in which obstructive jaundice interferes with the availability of the blood calcium is not well understood.

The bleeding tendency may become so marked that it leads to the patient's death. On account of this, certain measures have been advocated to correct this hæmorrhagic tendency, prior to operation. One of the most common procedures is the intravenous introduction of calcium in the form of calcium chloride or some other soluble calcium salt. Lee and Vincent¹ in 1915 were the first to advocate this form of treatment, and later Walters² and Whipple³ popularized it. The usual procedure, as advocated by Walters, consists of daily injections of five cubic centimetres each of a 10 per cent. solution of calcium chloride for three days just prior to operation. This form of treatment has been carried out on many patients with obstructive jaundice, operated upon at the Massachusetts General Hospital. However, in many of these cases it has not proven efficacious for the prevention of post-operative hæmorrhage. Because of this fact, a critical study has been made of the relation calcium bears to the coagulation of the blood in obstructive jaundice.

The Relation of Calcium to the Coagulation of Blood.—"In vitro" the rôle that calcium plays in the coagulation of normal blood is readily demonstrated by precipitating the calcium from the blood with a soluble oxalate salt, such as potassium oxalate, or by the addition of sodium citrate, in which case the calcium is bound to the citrate radicle and is no longer present in a utilizable form. Interference with the solubility and the ionization of the calcium by either of these methods prevents the blood from coagulating. Accordingly, the generally accepted theory is that calcium in a soluble and partially ionizable form is necessary for the coagulation of the blood.

Normal blood coagulates in six to twelve minutes, when the multiple tube method described by Lee and White⁴ is employed. The blood from patients with obstructive jaundice not uncommonly requires twenty to thirty minutes, or even longer, to coagulate by the same method. This lowered coagulability of the blood, as evidenced "in vitro," has been considered to

be due to a union of the blood calcium with bile circulating in the blood which rendered the calcium unavailable for the clotting of the blood.

This theory has never been proven. King and Stewart⁵ in 1909 were the first to hint at the possible advantages of calcium therapy in jaundiced patients. From their studies they concluded, "The bile pigments circulating in the blood in obstructive jaundice gradually absorb the available calcium of the organs and tissues to form calcium compounds." They thought that this was possibly a mechanism to protect the body against the deleterious effects of the bile circulating in the blood. They based this on the fact that, in their experiments on obstructive jaundice, they found an increase of 16 to 20 per cent. in the circulating blood calcium. However, more recent investigations by others have shown the blood calcium to be essentially normal in cases of obstructive jaundice.

King, Bigelow and Pearce⁶ in 1911 came to the same conclusion as King and Stewart. They were the first to suggest that the decreased coagulability of the blood in obstructive jaundice might be due to the fact that the calcium is bound to the biliary pigments in such a way as to be unavailable for the process of coagulation.

Later, Lee and Vincent¹ in 1915 were the first to advocate the use of calcium salts in the pre-operative preparation of jaundiced patients for the prevention of post-operative hæmorrhage. They advocated the use of the calcium "in vitro" test, and showed that the addition "in vitro" of calcium chloride to the blood from patients with obstructive jaundice increased the coagulability of it. This was the first direct evidence which indicated that there might be a deficiency in the available calcium. Here again, however, this test does not hold true in the majority of cases, as will be shown later in this paper. Lee and Vincent advocated calcium lactate by mouth, and also stated if a more prompt effect were desired, a soluble calcium salt could be given intravenously.

Following this report, Walters² in 1921 popularized the use of calcium chloride intravenously as a pre-operative measure in jaundiced patients. He reported a reduction in the mortality rate from post-operative hæmorrhage, in cases which received this form of treatment. Whipple³ in the same year recommended the use of pre-operative intravenous infusion of a 0.2 per cent. calcium lactate solution to prevent post-operative oozing.

Blood Calcium in Obstructive Jaundice.—If the theory is correct that the blood calcium combines with the bile pigments to make them relatively non-toxic and at the same time this union renders the calcium unavailable for the clotting of blood, then one should find an increase in the blood calcium in obstructive jaundice, proportional to the degree of jaundice; or a decrease in it, if one assumes the calcium is excreted along with the bile pigments. Accordingly, the blood-calcium level was investigated in a series of animals, in which obstructive jaundice had been produced by ligation and division of the common bile duct. Cats were used in this investigative work. All the animals rapidly developed marked jaundice. The degree of jaundice was followed with the quantitative van den Bergh test which indicates the number of milligrams of bilirubin per 100 cubic centimetres of serum. The animals lived a maximum of three to four weeks.

Calcium determinations were made before the jaundice was produced and repeated at intervals after ligation of the common bile duct, until the animal's death. These are shown in Table I. The Tisdall⁷ modification of the Kramer-Tisdall method was used for the calcium determinations. The normal blood calcium in cats was found to be essentially the same as in

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human blood. This is considered to be in the neighborhood of 9.0-11.0 milligrams of calcium per 100 cubic centimetres of serum. Some of the figures reported here are a little high, but not enough to interfere with the conclusions to be drawn from them.

TABLE I
Serum Calcium Values in Experimental Obstructive Jaundice

Animal	Pre-operative				Post-operative				
	Cal-cium†	Jaun-dice‡	10th Day		15th Day		20th Day		
			Cal-cium	Jaun-dice	Cal-cium	Jaun-dice	Cal-cium	Jaun-dice	
60	10.4	0	....	....	10.2	8.2	9.5	10.0	Death twenty-eighth day post-operative from hæmopericardium following cardiac puncture.
62	....	0	11.0	11.6	12.0	28.5	10.8	....	Death twenty-eighth day post-operative.
63	10.5	0	9.5	9.8	....	....	....	....	Death seventeenth day post-operative from ether.
67	12.1	0	11.0*	10.0*	....	....	....	....	Killed fifth day post-operative because wound was septic.
69	12.4	0	11.6	15.0	....	....	....	....	Death twelfth day post-operative from cardiac puncture with hemopericardium.
79	11.6	0	11.2	....	....	....	13.2	12.4	Death on twenty-sixth day post-operative.

* These figures were from blood taken on the fifth day post-operatively.

† Calcium figures are expressed in milligrams of calcium per 100 cubic centimetres of serum.

‡ Jaundice is expressed in milligrams of Bilirubin per 100 cubic centimetres of serum in all tables.

Following the development of the jaundice which became marked in a few days, there was practically no change in the blood-calcium level. In two instances, animals 60 and 79, figures as high as 13.0 milligrams were obtained. I think these were probably due to errors in technic. Thus in animal 60 the blood-calcium level the day before was 9.5 milligrams. The remainder of the figures varied from 9.5 milligrams to 12.0 milligrams. These are within the range of the calcium level in six normal cats, which varied from 10.4 milligrams to 12.4 milligrams. From these experiments the conclusion to be drawn is that obstructive jaundice of a marked degree in cats, lasting as long as three weeks, does not affect the blood-calcium level. There is neither an accumulation of it along with the bile pigments nor is there a diminution of it due to an increased excretion of it.

Similar determinations were made on a series of patients with obstructive jaundice. Table II gives the results in this group. These patients were all operated upon. Some of them developed post-operative hæmorrhage, but even in these the blood-calcium level remained normal. Case 6 had the lowest figure, which was 7.2 milligrams, but this represented the calcium level of the plasma instead of the serum. In Case 3 the calcium level was 8.8 milligrams, which is practically normal, despite obstructive jaundice of twelve months' duration.

In Table III I have tabulated serum calcium levels reported by a number

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of other investigators. All the figures, both experimental and clinical, except those reported by Buchbinder and Kern¹² in their experimental studies in puppies with obstructive jaundice, and those in three cases, reported by Kirk and King,⁸ are essentially the same as I have reported.

A reduction of the blood-calcium level to 5-7 milligrams per 100 cubic centimetres of plasma produces signs of tetany, according to Sollman.¹³ Despite this decrease in blood calcium, no interference of the coagulability

TABLE II
Serum Calcium Values in Jaundiced Patients

Case	Diagnosis	Duration of Jaundice	Degree of Jaundice	Calcium
1.	Cholelithiasis with stone in the Common Bile Duct.....	2 weeks	7.0	10.4
2.	Carcinoma of Pancreas with Obstructive Jaundice.....	6 weeks	24.0	10.4 and 9.5
3.	Carcinoma of Pancreas with Obstructive Jaundice.....	12 months	16.0	8.8
4.	Carcinoma of Pancreas with Obstructive Jaundice.....	2 weeks	16.0	11.0
5.	Post-operative Stricture of the Common Bile Duct.....	3 months	21.0	9.0
6.	Carcinoma of Biliary Passages with Obstructive Jaundice.....	2 weeks	18.75	7.2*
7.	Carcinoma of Pancreas with Obstructive Jaundice and Cholelithiasis.....	12 days	21.0	11.4 and 10.3
8.	Carcinoma of Pancreas with Obstructive Jaundice.....	2½ weeks	18.0	10.3
9.	Cholelithiasis with Stone in Common Bile Duct.....	2 weeks	16.0	10.9 and 10.5

* This was determined from plasma instead of serum.

of the blood in these cases has ever been noted. Simpson and Rasmussen¹⁴ found no decrease in the coagulability of the blood in the thyroparathyroid-ectomized animals in which tetany was produced. In the cases of obstructive jaundice I have studied, the blood-calcium level was never diminished sufficiently to produce signs of tetany, which indicates that there was sufficient calcium in the blood for purposes of coagulation.

Zimmerman¹⁵ in 1927 brought forward some important evidence to show that the diminished coagulability is not due to a lack of calcium in the blood. He was able by the use of parathormone to increase the blood calcium to double the normal value in cases of obstructive jaundice. Despite this great increase in the circulating blood calcium he found no increase in the coagulability of the blood in obstructive jaundice.

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Further proof that in obstructive jaundice there is sufficient calcium for the coagulation of blood is brought forward by Kirk and King.⁸ They used an ultra-filtration method for determining the diffusible calcium in the blood and came to the conclusion that the percentage of ultrafilterable calcium found in the blood in obstructive jaundice was below that in normal blood, but the difference was not sufficiently great to account for the frequent delayed coagulation time in jaundice.

The Effect of Calcium Chloride on the Coagulability of the Blood.—The calcium "in vitro" test was first described by Wright¹⁵ in 1893, and later advocated by Lee and Vincent¹ and Walters² in cases of obstructive jaundice. It consists of adding a few drops of a 1 per cent. solution of calcium chloride to a sample of blood, and recording the time it requires to clot. This is frequently found to be considerably shorter than the coagulation time of the blood without the addition of the calcium salt, according to the above inves-

TABLE III
Blood Serum Calcium Determinations from the Literature

Investigator	No. Cases	Normal Calcium Values Minimum and Maximum	No. Cases	Jaundiced Calcium Values Minimum and Maximum
Kirk & King ⁸	7	7.43 to 13.94	6	6.94 to 11.39 (one as low as 4.31)
Cantarow, Dodek & Gordon ⁹	6	10.09 to 10.45	10	9.3 to 11.3
Snell, Greene & Rowntree ¹⁰ ..	..	.....	3 dogs	9.1 to 11.0
Zimmerman ¹¹	9 dogs	10.3 to 11.2	6 dogs	10.1 to 10.9
Zimmerman ¹¹	6 patients	9.6 to 10.7	5 patients	9.2 to 10.7
Buchbinder & Kern ¹²	5 dogs	9.4 to 10.5	4 dogs	5.1 to 8.0

tigators. This fact has led to the support of the belief that there is a deficiency in the available calcium.

The above test has been carried out on many cases of obstructive jaundice in this hospital. Analysis of a series of these does not point to a deficiency in available calcium in obstructive jaundice.

The multiple-tube method for determining the coagulation time, described by Lee and White⁴ was the one used in the following cases. Four or five tubes one centimetre in diameter are used. One cubic centimetre of blood is placed in each tube. Three drops of a 1 per cent. solution of calcium chloride are put in the last tube and in this way the calcium "in vitro" coagulation time is obtained. This is according to the original technic of Lee and Vincent.¹

I have collected from the records of the Massachusetts General Hospital fifteen cases of obstructive jaundice in which this test has been carried out. In some of the cases it was repeated several times, so that in all the results of the test in twenty-three samples of blood were obtained. These figures are tabulated in Table IV. Examination of them show that in seventeen of the twenty-three tests the calcium "in vitro" time was longer than in the untreated blood, while in only six cases was it shorter. In the

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latter, the decrease was practically negligible or the coagulation time of the untreated blood was within normal limits.

I believe the reason the calcium "in vitro" figures are longer than the other figures is that the tube in which the calcium is placed is usually the last tube to be tilted in order to determine the coagulation time. The important fact proven by these figures, however, is that in the great majority of these tests the addition of calcium ions did not hasten the coagulation time.

TABLE IV
Calcium "in vitro" Coagulation Tests in Patients with Obstructive Jaundice

Case	Diagnosis	Age and Sex	Duration of Jaundice	Degree of Jaundice	Coagulation Time in Min.	Calcium "in vitro" Coagulation Time in Min.
1.	Carcinoma of Pancreas.....	59 M	1 wk.	II* 100	8	15
2.	Carcinoma of Pancreas.....	47 M	2 wks.	II 75	11½	9
3.	Carcinoma of Pancreas.....	55 F	4 wks.	II 75	18	27
4.	Carcinoma of Pancreas.....	61 M	4 wks.	II 75	22	18
5.	Carcinoma of Pancreas.....	57 M	6 wks.	II 70	19	16
6.						
7.	Stenosis of Common Duct.....	28 F	11 wks.	++++	12	12
8.	Stenosis of Common Bile Duct.....	35 F	4 wks.	II 15	10	7
9.	Stenosis of Common Bile Duct.....	37 F	3 wks.	++	10	12
10.	Carcinoma of Pancreas.....	60 F	3 wks.	19.5	21	22
				II 100.0++		
	Carcinoma of Pancreas.....				26	23
	Carcinoma of Pancreas.....				14	25
11.	Stricture of Common Bile Duct.....	33 F	5 mos.	21.41	30	34
	Stricture of Common Bile Duct.....				14	25
	Stricture of Common Bile Duct.....				20	23
	Stricture of Common Bile Duct.....				22	26
	Stricture of Common Bile Duct.....				12	16
12.	Carcinoma of Head of Pancreas.....	48 F	9 wks.	II 100+	10	70
	Carcinoma of Head of Pancreas.....				9	No clot in 2 hrs.
	Carcinoma of Head of Pancreas.....				10	7
13.	Carcinoma of Head of Pancreas.....	47 M	3 wks.	25	16	26
14.	Common Duct Stone.....	42 M	1 wk.	+++	38	33
15.	Carcinoma of Head of Pancreas.....	55 M	4 wks.	25.0	15	34

*I. I.—Icteric Index.

Further proof that this test does not indicate a lack of available calcium in the blood was shown by comparing the calcium "in vitro" and sodium "in vitro" coagulation times on the blood of an animal in which obstructive jaundice had been produced by ligation and division of the common bile duct.

Blood for this purpose was obtained from animal 79, after marked jaundice had developed and the coagulation time of the blood had become greatly increased. The method used for the determination of the coagulation time was the Schwarz-Ottenberg modification of Milian method¹⁶ which is a hanging drop preparation. This was used because it requires only a small quantity of blood and it also gives a fairly definite end-point.

Determinations were made on four different occasions, over a period of six days. The blood was obtained with extreme care from the saphenous vein. A clean syringe and needle were used for each determination. Three specimens were obtained, each of 2 cubic centimetres, and all within a very few minutes of each other. No solution was added to the first specimen. In the second syringe 0.2 of a cubic centimetre of 1 per cent. solution of calcium chloride, and in the third one the same amount of normal saline was

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introduced before withdrawing the blood. The latter two specimens had to be rotated gently to mix the blood and solutions. This agitation and the dilution of the blood, I think, explains why the blood samples treated with the above salts clotted more rapidly than the untreated samples.

The results are tabulated in Table V. In all instances both the calcium and the sodium "in vitro" coagulation times were shorter than the normal ones. There was notably little difference between the calcium and the sodium figures, indicating that additional calcium has no direct effect on increasing the coagulability of jaundiced blood.

TABLE V
Calcium and Sodium "in vitro" Coagulation Times

Days Post-operative	Icteric Index	Coagulation Time without Solution	Calcium Chloride Coagulation Time	Sodium Chloride Coagulation Time
17	100+	126 min.	97 min.	93 min.
19	100+	76 min.	60 min.	39 min.
21	100+	103 min.	44 min.	67 min.
23	100+	40 min.	15 min.	25 min.

The effect of the intravenous administration of calcium chloride on the coagulation time was also studied in jaundiced patients who were being prepared for operation. In Table VI I have tabulated the coagulation times of nine patients with a high grade of obstructive jaundice, before and after calcium therapy. The dosage varied from 5 cubic centimetres of a 10 per cent. solution of calcium chloride to 30 cubic centimetres of a 5 per cent. solution. The number of injections varied from a minimum of two in some cases to a maximum of seven in one case.

In seven of these cases the coagulation time was found to be longer after the intravenous calcium therapy than it was before. Case 7 received seven injections without increasing the coagulability of the blood. Thus before the treatment was instituted the coagulation time was fifty-one minutes, and after the seventh injection, it was ninety-four minutes. This last figure was obtained just eight minutes after the last calcium treatment had been given, when the calcium ions in the blood should have been at a maximum. In Case 8, after six injections there was a drop from twenty-one to fourteen minutes, although after the fifth injection the coagulation time was still twenty-eight minutes. Case 9 showed a drop from thirty-eight to thirty-three minutes after two injections. Thus of these nine cases, only two showed any decrease in the coagulation time of the blood. In one of these, Case 9, the increase was negligible, and in the other, Case 8, it was questionable.

The Administration of Calcium for Post-operative Bleeding.—In three cases which developed post-operative bleeding, calcium chloride intravenously did not control the hæmorrhage. On two occasions it was used for a woman of thirty-seven with obstructive jaundice due to a stone in the common bile

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duct. Two operations were performed before the stone was removed, and in both instances the patient developed post-operative bleeding, which was not controlled by calcium chloride intravenously. Direct blood transfusion had to be resorted to each time. In another case of a man seventy years old with obstructive jaundice due to carcinoma of the head of the pancreas, in which a cholecystgastrostomy was done, bleeding from the wound commenced on the seventh day post-operatively. Calcium chloride given intravenously failed to check the bleeding, and it was controlled only by direct blood transfusion.

TABLE VI

The Effect of Intravenous Calcium Chloride on the Coagulation Time in Obstructive Jaundice

Case	Diagnosis	Age and Sex	Duration of Jaundice	Degree of Jaundice	No. Pre-op. Injections Calcium Chloride	Coag. Time in Minutes Prior to Injections	Coag. Time in Minutes after Injections
1.	Carcinoma of Pancreas with Obstructive Jaundice.....	46 M	12 mos.	16.0	3	18	18
2.	Cholelithiasis and Carcinoma of Pancreas.....	39 M	12 days	21.0	5	32	33
3.	Cholelithiasis with Stone in Common Bile Duct.....	39 F	2 wks.	16.0	4	18	30
4.	Carcinoma of Pancreas with Obstructive Jaundice.....	75 M	1 wk.	18.75	2	26	35
5.	Carcinoma of Pancreas with Obstructive Jaundice.....	41 M	2 wks.	18.0	2	26	30
6.	Carcinoma of Pancreas with Obstructive Jaundice.....	45 M	6 wks.	24.0	2	14	16
7.	Carcinoma of Pancreas with Obstructive Jaundice.....	66 M	11 wks.	19.75	7	41	94*
8.	Carcinoma of Pancreas with Obstructive Jaundice.....	60 F	1 wk.	19.0	5th 6th	21 21	28 14
9.	Cholelithiasis with Stricture Common Bile Duct.....	42 M	4 days	+++	2	38	33

* This determination was made 8 minutes after the seventh injection of calcium chloride.

The fourth occasion it was used for a woman of twenty-seven with obstructive jaundice due to a stone impacted in the common bile duct. Bleeding started following the removal of the abdominal drain on the tenth day post-operatively. The oozing again was not controllable with intravenous calcium chloride, and direct blood transfusion had to be resorted to.

It is true that in these four instances, only one injection of 5 cubic centimetres of a 10 per cent. solution of calcium chloride was used. Further delay did not seem justifiable, to determine if additional calcium treatment would be of value, so transfusion was resorted to in each case. Pre-operative preparation with intravenous calcium chloride was also used in three of the four instances cited above.

Operative Results—Post-operative Bleeding.—In a series of forty patients with obstructive jaundice, operated upon chiefly in the past two years at this hospital, twenty-three received pre-operative preparation with two or more injections of 5 or 10 per cent. calcium chloride, while seven-

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TABLE VII
Post-operative Hemorrhage in Cases of Obstructive Jaundice Prepared with Calcium Chloride Pre-operatively

Case	Diagnosis	Age and Sex	Duration of jaundice	Degree of jaundice	No. Calcium Chloride Treatments	Post-op. Bleeding	Operation	Anesthesia Duration	End-result
1.	Cholelithiasis with Stone in Common Bile Duct.....	39 F	2 wks.	16.0	4 Injections sec. 10 per cent.	++	Cholecystectomy and Choledochostomy	Ether 2°	Home
2.	Carcinoma of Pancreas with Obstructive Jaundice.....	75 M	2 wks.	18.75	2—15cc. 5 per cent.	++	Cholecystogastrostomy	Spinal 1°	Death from hemorrhage 15 days post-op.
3.	Pancreatitis with Obstructive Jaundice.....	41 M	2½ wks.	18.0	2—5cc. 10 per cent.	+	Cuolecystogastrostomy	Ether 1° 15°	Home
4.	Carcinoma of Pancreas with Obstructive Jaundice.....	62 M	6 wks.	24.0	2—5cc. 10 per cent.	0	Cholecystogastrostomy	Spinal 1°	Death 4th day post-op.
5.	Carcinoma of Pancreas with Obstructive Jaundice.....	46 M	12 mos.	16.0	3—10cc. 5 per cent.	0	Aspiration of Gall-Bladder	Local	Death 4th day post-op., broncho-pneumonia
6.	Carcinoma of Pancreas and Cholelithiasis with Obstructive Jaundice.....	39 M	12 days	21.0	5—15cc. 5 per cent.	+	Cholecystostomy and Choledochostomy	Spinal 2°	Death 6th day post-op., hepatitis and broncho-pneumonia
7.	Cholelithiasis with Stone in Common Bile Duct.....	42 M	4 days	+++	2—5cc. 10 per cent.	0	Cholecystectomy and Choledochostomy	Ether 2° 30°	Home
8.	Post-op. Stricture Common Bile Duct.....	33 F	3 mos.	21.0	3—10cc. 5 per cent.	0	Drainage of Hepatic Duct and Transfusion	Spinal 2° 23°	Home
9.	Stricture Common Bile Duct with Biliary Fistula.....	33 F	0	0	3—10cc. 5 per cent.	+++	Transplant of Biliary Sinus in Duodenum and trans-fusion	Spinal 1° 50°	Home
10.	Stone in Common Bile Duct with Jaundice and Pregnancy.....	27 F	2 wks.	++++	3—5cc. 10 per cent.	+++	Cholecystectomy and Choledochostomy	Ether 1° 40°	Home
11.	Cancer of Pancreas with Obstructive Jaundice.....	60 F	1 wk. +	19.0	3—10cc. 5 per cent.	0	Cholecystostomy	Spinal 30°	Death 11th day post-op., broncho-pneumonia
12.	Cancer of Liver with Obstructive Jaundice.....	60 F	6 wks.	25.0	2—15cc. 5 per cent.	+	Cholecystectomy and Choledochostomy	Ether 2°	Death 5th day post-op., hepatitis and pneumonia
13.	Cancer of Biliary Passages with Jaundice.....	38 M	8 wks.	31.0	3—10cc. 5 per cent.	+++	Cholecystogastrostomy	Spinal 1° 44°	Death 6th day post-op., hemorrhage

TABLE VII (Continued)

Case	Diagnosis	Age and Sex	Duration of Jaundice	Degree of Jaundice	No. Calcium Chloride Treatments	Post-op. Bleeding	Operation	Anesthesia Duration	End-result
14.	Cancer of Biliary Passages with Jaundice.....	57 F	7 wks.	18.75	3-10cc. 5 per cent.	0	Exploratory Laparotomy	Spinal 1°	Death 15th day post-op., (?) broncho-pneumonia
15.	Cancer of Pancreas with Jaundice.....	53 M	4 wks.	14.25	2-10cc. 5 per cent.	0	Cholecystgastrostomy	Spinal 1°	Home
16.	Cancer of Pancreas.....	66 M	11 wks.	19.75	7-15cc. 5 per cent.	+	Cholecystgastrostomy, Jejunostomy and transection	Spinal 2°	Death 4th day post-op., pneumonia and some hemorrhage
17.	Stricture Common Bile Duct with Jaundice.....	36 F	3 mos.	++ ++	3-10cc. 5 per cent.	++ ++	Plastic Operation to Common Bile Duct	Ether 1° 50'	Death 2nd day post-op., hemorrhage
18.	Stricture Common Bile Duct with Jaundice.....	37 F	12 mos.	++ ++	3-10cc. 5 per cent.	+	Anastomosis of Hepatic and Common Duct	Ether 2° 30'	Death 9th day post-op.
19.	Cancer of Head of Pancreas.....	47 M	2 wks.	11 50 +	2-10cc. 5 per cent.	0	Cholechooduodenostomy	Ether 2° 15'	Home
20.	Cancer of Pancreas.....	47 M	4 wks.	11 70	3-10cc. 5 per cent.	++ ++	Cholecystgastrostomy	Ether 1° 15'	Death 2nd day post-op.
21.	Stricture Common Bile Duct.....	47 M	2 wks.	11 50 +	3-10cc. 5 per cent.	++ ++	Cholechootomy	Ether 1° 30'	Home
22.	Cancer of Pancreas.....	59 M	4 wks.	11 100	3-10cc. 5 per cent.	++ ++	Cholecystgastrostomy	Ethylene 1° 25'	Home
23.	Toxic Hepatitis.....	30 M	3 wks.	15.0	3-10cc. 5 per cent. Ca. Gluconate grna. xx for 19 days pre-op.	+	Exploratory Laparotomy	Spinal 30'	Home against advice; still bleeding 10th day post-op. Received 2 post-op. transfusions.

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TABLE VIII
Post-operative Hemorrhage in Cases of Obstructive Jaundice Not Prepared with Calcium Chloride Pre-operatively

Case	Diagnosis	Age and Sex	Duration of jaundice	Degree of jaundice	No. Calcium Chloride Treatments	Post-op. Bleeding	Operation	Anesthetic Duration	End-result
1.	Carcinoma of Pancreas with Obstructive jaundice.....	50 M	wks.	16.0	0	0	Cholecystostomy	Ether 1°10°	Death in 36 hrs.
2.	Cholelithiasis with Stone in Common Bile Duct.....	37 M	2 wks.	7.0	0	0	Cholecystectomy and Cholecdochostomy	Ether 2°	Home
3.	Cholelithiasis with Jaundice	45 M	4 days	15.0	0	0	Cholecdochostomy	Ether 2°	Home
4.	Cholelithiasis with Stone in Common Bile Duct.....	48 F	10 wks.	5.25	0	0	Cholecystectomy and Cholecdochostomy	Ether 1°10°	Home
5.	Carcinoma of Pancreas with Jaundice.....	44 M	6 wks.	10.13	0	0	Cholecystagastrotomy	Ether 1°	Home
6.	Cholelithiasis, Acute Yellow Atrophy.....	50 F	5 days	12.0	0	0	Cholecystectomy and Cholecdochotomy	Ether 2°	Death 50th day post-op., acute yellow atrophy
7.	Carcinoma of Pancreas with Jaundice.....	47 M	3 wks.	25.0	0	0	Exploratory Laparotomy	Spinal 1°	Death
8.	Infectious Hepatitis.....	51 M	7 wks.	24.75	0	+	Exploratory Laparotomy	Ether 45°	Home
9.	Cholelithiasis with Stone in Common Bile Duct.....	49 F	4 wks.	13.0	0	++	Cholecystectomy and Cholecdochotomy	Ether	Home
10.	Same.....	50 F	5 wks.	17.25	0	++	Cholecdochostomy	Spinal 1°30°	Home
11.	Stone in Common Bile Duct with Biliary Fistula.....	39 F	0	0	0	+	Cholecdochostomy	Ether 2°30°	Home
12.	Carcinoma of Pancreas with Obstructive Jaundice.....	59 M	1 wk.	21.3 mg.	0	0	Cholecystagastrotomy	Spinal 1°20°	Home
13.	Stricture Common Bile Duct.....	28 F	11 wks.	+++	0	0	Cholecdochoduodenostomy	Ether 2°30°	Home
14.	Stricture Common Bile Duct.....	37 F	4 wks.	++	0	0	End-to-end Suture Common Bile Duct	Ether 2°20°	Home
15.	Cholelithiasis with Jaundice.....	48 F	1 wk.	20.81	0	0	Cholecystectomy and Cholecdochotomy and Transfusion for Shock	Ether 1°30°	Home
16.	Cholelithiasis with Jaundice.....	71 M	2 wks.	11.42	0	0	Cholecystectomy and Cholecdochotomy	Ether 1°45°	Death 20th day post-op., pneumonia and cardiac failure
17.	Carcinoma of Pancreas with Jaundice.....	49 M	2 wks.	11.70	0	0	Cholecystagastrotomy	Ether 1°15°	Home

teen did not receive any calcium chloride. (See Tables VII and VIII.) Bleeding took place in fifteen cases, or 65 per cent. of the former group. This varied in severity from strongly positive guaiac tests in the stools to death from uncontrollable hæmorrhage. The most striking example was Case 16 who died four days post-operatively from broncho-pneumonia and hæmorrhage. This patient received in all seven injections of 15 cubic centimetres of a 5 per cent. solution of calcium chloride. A transfusion was also given the day of operation, but despite this and the intensive calcium therapy, bleeding took place, which definitely hastened his death.

In the group operated upon without calcium therapy, bleeding took place in only four cases, or 23 per cent. of the seventeen. The two groups are similar in that the degree and duration of the jaundice was marked in practically all cases. Then also, the extent of the operations on the biliary system in the two groups was nearly the same. The remainder of the pre-operative preparation was similar in both groups. The anæsthetic used in most of these cases was ether, although spinal was used in some cases of both groups. Local anæsthesia and ethylene were used in one case each.

According to these figures, the cases which received no calcium chloride did not have such a high percentage of post-operative hæmorrhage as the ones which were prepared pre-operatively with it. The reason for this is partly due to the fact that seven of these seventeen cases were selected cases, as they had slow blood sedimentation rates. According to a recent article by the author¹⁷ it can be predicted that post-operative hæmorrhage is not likely to occur as long as the sedimentation rate remains slow. On the other hand it is unlikely that calcium chloride injections increase the hæmorrhagic tendency, as the above figures seem to indicate. The most important conclusion to be drawn, however, is that calcium chloride does not seem to guard against post-operative hæmorrhage.

The Effect of Calcium Chloride Therapy on the Blood Sedimentation Rate.—The sedimentation rate of the blood seems to be of value in predicting which patient may bleed post-operatively.¹⁷ Patients with a slow or normal rate do not bleed, while those with rapid rates are apt to bleed. Calcium chloride therapy had no effect on the sedimentation rate in five cases on which the test was done before and after the treatment. The results are tabulated in Table IX. Four of these cases had very rapid rates and in all the sedimentation rate was more rapid following the calcium therapy. This was undoubtedly because the patients were becoming worse between the two determinations. In the fifth case, the rate was relatively slow before, and remained essentially the same following the treatments.

The Effect of Calcium Chloride Therapy on the Post-operative Mortality Rate.—The recent investigations of Lamson, Minot and Robbins,¹⁸ in reference to the protective action of calcium in cases of carbon tetrachloride intoxication, is perhaps evidence that calcium may be of value in cases of obstructive jaundice with severe liver damage. Study of the causes of death in the above series of forty cases does not point to a protective action from

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TABLE IX

Effect of Calcium Chloride on the Sedimentation Rate of the Blood

Case	Diagnosis	Age and Sex	Duration	Degree	No. Calcium Chloride Injections	Sed. Rate Before	Sed. Rate After
1.	Toxic Hepatitis.....	36 M	3 wks.	15.0	3—10cc. 5 per cent. and Ca. gluconate Gr. xx for 18 days	9 mm.	11 mm.
2.	Carcinoma of Bile Ducts.....	48 F	6 wks.	30.0	3—10cc. 5 per cent.	65 mm.	74 mm.
3.	Carcinoma of Pancreas.....	38 M	8 wks.	31.0	3—10cc. 5 per cent.	32 mm.	40 mm.
4.	Carcinoma of Pancreas.....	53 M	4 wks.	19.75	7—15cc. 5 per cent.	48 mm.	50 mm.
5.	Carcinoma of Bile Ducts.....	57 F	7 wks.	18.75	3—10cc. 5 per cent.	48 mm.	58 mm.

the pre-operative use of intravenous calcium chloride. In the group of twenty-three patients treated with calcium chloride there were thirteen deaths, a post-operative mortality rate of 56.5 per cent. Nine of these were due directly to hæmorrhage or hepatic insufficiency, a mortality rate of 39.1 per cent.

In the group of seventeen patients who received no calcium therapy, there were three deaths, a mortality rate of 17.6 per cent. None of these was due to hæmorrhage. Two of these deaths were directly related to hepatic insufficiency, a mortality rate of only 11.7 per cent. from this cause. (See Tables VII and VIII.)

Discussion.—The cause of the lowered coagulability of the blood in cases of obstructive jaundice has been considered to be due to the presence of bile pigments in the circulation. The mechanism by which these pigments delay the coagulation of the blood has never been fully explained. A number of years ago the theory was advanced that the bile pigments united with the available calcium in the blood-stream, and this in some way changed the calcium into a non-utilizable form for the process of coagulation.

This theory has never been satisfactorily proven, but it has been accepted by many as the most logical explanation of the lowered coagulability of the blood in obstructive jaundice. Furthermore, the pre-operative preparation with intravenous injections of a soluble calcium salt in cases of obstructive jaundice has been based on this assumption.

Zimmerman¹¹ in 1927 challenged the efficacy of calcium therapy in these cases. He pointed out that there is no sound theoretical basis for its possible effect on the coagulability of the blood.

The tendency to bleed does not depend on the degree nor the duration of the jaundice. Some cases of biliary fistula with no retention of bile pigments in the blood-stream have a very marked bleeding tendency. For such cases the above theory will not suffice.

Quantitative determinations of the serum calcium, both in experimental and clinical obstructive jaundice, have shown no deficiency nor accumulation. The addition of calcium chloride to jaundice blood "in vitro" in the majority of cases reported here does not increase the coagulability of the

blood. Experimentally in one case the addition of sodium chloride "in vitro" produced a shortening of the coagulation time equal to that by the addition of calcium chloride. This shortening of the coagulation time was probably due to agitation and dilution of the specimens, and not due to any specific effect of the sodium or calcium ions.

After the administration of calcium chloride intravenously to patients with obstructive jaundice, the coagulability of the blood was not increased in the majority of cases. The incidence of post-operative hæmorrhage was not decreased in a series of patients which received calcium therapy pre-operatively, as compared with a similar group which did not receive calcium. The administration of calcium chloride intravenously does not stop post-operative hæmorrhage at the time it is taking place. In the above group of cases prepared with intravenous calcium chloride the mortality rate from hæmorrhage and hepatic insufficiency was higher than in the group which received no calcium therapy.

If a case of obstructive jaundice presents a rapid blood sedimentation rate, indicating a hæmorrhagic tendency, a direct blood transfusion, given within twenty-four hours of operation, and repeated if necessary, is the most valuable and effective means of protecting against post-operative bleeding that we have at the present time.

CONCLUSIONS

1. The administration of calcium in obstructive jaundice has no theoretical or practical basis for the prevention of post-operative hæmorrhage.
2. The lowered coagulability of the blood in cases of obstructive jaundice does not seem to be due to a deficiency nor an abnormality of the blood calcium.
3. The most effective means of preventing and stopping post-operative hæmorrhage in obstructive jaundice at present is repeated direct blood transfusions used in conjunction with a high pre- and post-operative carbohydrate and fluid intake.

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THE USE OF EXPLORING NEEDLES AND SHADOW-CASTING MEDIA IN THE DIAGNOSIS OF HEPATIC AND PERIHEPATIC ABSCESS

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THE use of satisfactory shadow-casting media for observing the contour of hollow viscera or the shape and extent of cavities has become of salient importance to the medical man of today. The use of opaque substances in abdominal viscera has largely eliminated the necessity for exploratory operations.

In hepatic or perihepatic abscess, however, it still seems to be the opinion of many that usually the diagnosis can be made only by an exploratory operation. The diagnosis is often very difficult in hepatic and perihepatic abscess. The history is in most cases suggestive. Previous intra-abdominal pathology may suggest the possibility, but in obscure abdominal cases where symptoms of infection are present, it is well to bear in mind that there may be an abscess of the liver or perihepatic spaces. Irregular temperature, sweating, wasting, and progressive secondary anaemia should arouse suspicion, and if added to this the patient complains of some fullness, discomfort or pain in the upper abdomen, the condition warrants further examination.

The X-ray is frequently of extreme value in suggesting the location of a suppurative process about the liver. The elevation and the diminished mobility of the diaphragm, and in some instances an alteration of the contour resulting from a local collection of pus beneath the diaphragm, may point very decidedly to the spot to which the exploring needle should be directed.

The active treatment of hepatic or perihepatic abscess is necessarily surgical and it should be instigated as soon as practical after the diagnosis is made. This is a condition in which time is an important factor, therefore early recognition with proper treatment should lower the very high fatality rate which now exists. If the history of onset and course are correlated with a carefully made X-ray examination, and is then followed by localization with the exploring needle, injection of iodized oil and further X-ray pictures, there may be prevented the frequent procrastination in the application of proper surgical measures.

Both hepatic and perihepatic abscesses, whether occurring from amœbic infection or resulting from pyogenic organisms, will be considered together in the question of early diagnosis by the use of the exploring needle and injection of iodized oil.

One is rather hesitant in advocating the exploring needle after reading in the surgical literature such statements as, "Aspiration has been recom-

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mended by some. It is unsurgical"; and "For years it has been common practice to employ the aspirating needle in making a diagnosis. I am glad the practice is going out of fashion. I cannot lay sufficient emphasis on the futility of this custom." And yet those of us who have "done time" in the Tropics, where pathological conditions of the liver region are so common as compared to the frequency in the United States, cannot but feel that the exploring needle has a very definite place in suspected hepatic or perihepatic abscess. We are somewhat inclined to agree with Sir Leonard Rogers when he states, in speaking of amœbic abscess, "There is probably no serious tropical disease in which so much advance has been made during the last

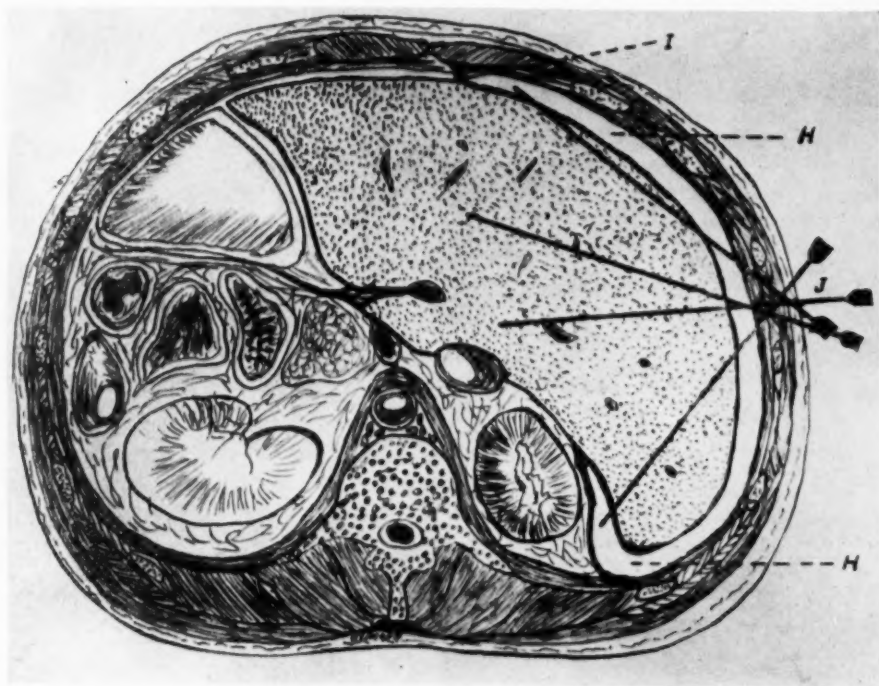


FIG. 1.—Illustrating method of locating hepatic or perihepatic abscesses. *H*.—Potential cavity between the liver and right costal area. *I*.—Suspensory (falciform) ligament of the liver, which forms an efficient barrier to abscesses anterior to the liver. *J*.—Point of insertion of needles in ninth or tenth interspace in exploring for hepatic or perihepatic abscess. Cross-section at level of first lumbar vertebra.

quarter of a century, both in prevention and cure, as in amœbic hepatitis and its sequel, liver abscess. . . . Aspiration is the method of choice." Sir Frank Powell Conner states, "It must be explained at the onset that the treatment of amœbic liver abscess by open incision is becoming an increasing rare operation. It is not a question of timid surgery."

The patient with a hepatic or perihepatic abscess is usually acutely ill. The condition of the patient becomes progressively worse unless the abscess is diagnosed and treated early. The use of the exploring needle as a diagnostic means permits of an early diagnosis without resorting to a major

operation, and with a minimum of shock. For those abscesses resulting from amoebic infection which are found to be sterile (and this includes, statistics show, 86 per cent. of all amoebic abscesses), the aspirating needle is not only of importance for diagnosis but also for treatment. In hepatic and perihepatic abscesses resulting from pyogenic organisms or in which pyogenic organisms are present in smear or culture, the aspirating needle is recommended only as a means for diagnosis and not as a means of treatment.

The exploring needle has its limitations as it can be used with safety only in hepatic or perihepatic abscess involving the right lobe of the liver. However, when one considers that more than 80 per cent. of amoebic

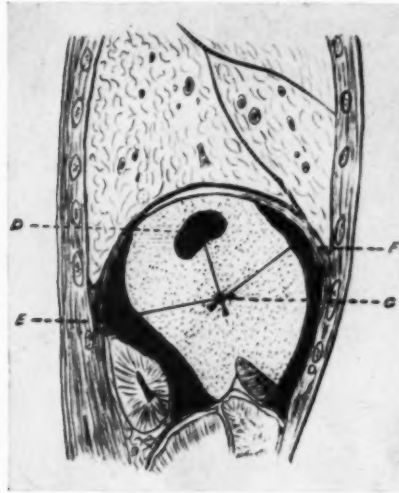


FIG. 2.—Diagram taken to the right of the mid-line. *D*.—Liver abscess. *E*.—Abscess posterior perihepatic space. *F*.—Abscess anterior perihepatic space. *G*.—Point of insertion of needles for diagnosis and localization of hepatic or perihepatic abscess ninth or tenth intercostal space.

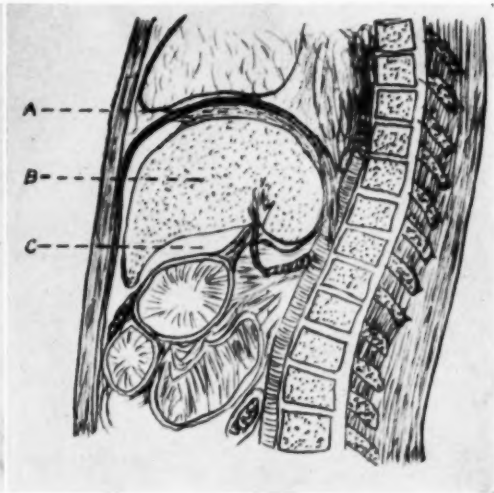


FIG. 3.—Diagram illustrating potential perihepatic spaces. *A*.—Extra peritoneal space corresponding to the fore spot of the liver. *B*.—The liver. *C*.—Potential cavity about liver where abscess may occur.

abscesses occur in the right lobe, and that seldom is a perihepatic abscess found except about the right lobe, its range of usefulness is great.

In considering exploration for an abscess cavity, it is well to remember that on the right side there are three perihepatic spaces where abscess may be found. The anterior perihepatic space lies between the superior, anterior and to some extent the lateral aspect of the right lobe of the liver and below the diaphragm. Its left border is the falciform ligament, and its right may be at a level with the right lateral ligament. The space is usually limited below in case of suppuration by adhesions between the greater omentum, the transverse colon or between the liver and the abdominal or chest wall.

The second space of importance is the posterior perihepatic space. It lies beneath the right lobe of the liver. Above and posteriorly lies the diaphragm and separated only by the parietal peritoneum is the right kidney.

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The right lateral ligament of the liver somewhat limits it from above. Below the transverse colon by adhesions usually forms the lower boundary.

The right extraperitoneal space is a potential cavity formed of loose fibrous tissue, corresponding to the bare area of the liver. It is bounded by the liver on the one side and by the fibrous and muscular tissue of the diaphragm on the other. It is limited laterally by the lateral ligament of the right lobe of the liver and above and below by the coronary ligament and reflected peritoneum. The formation of an abscess in this space may result from extension from a liver abscess, by extension from an anterior or a posterior perihepatic abscess, or following suppuration of the abdominal cavity by extension *via* the lymphatics, or from purulent infections above the diaphragm.

With the patient lying on his back, or with the right side elevated above the left, on the operating or fluoroscopic table, the liver dullness is carefully mapped out. If there are no signs of a pointing abscess, and there will not be unless unnecessary delay in attempting diagnosis has occurred, the point at which the exploring needle is to be inserted is determined upon and the area infiltrated with novocaine. If the X-ray and physical examination indicate obliteration of the costophrenic angle, it is quite safe to use the ninth interspace in the anterior or mid-axillary line. If the X-ray shows no obliteration of the costophrenic angle, it is safer to use the tenth interspace.

The regular spinal puncture needle with fairly blunt point with a three- and one-half-inch reach is the safest type of needle. For the posterior or anterior perihepatic spaces, however, a longer needle with at least a four-inch reach may be required.

Insert the needle slowly after penetrating the chest wall. If slight resistance is encountered and the general direction of the needle gives assurance that one is not against the capsule of the liver or a large vessel, withdraw the needle slightly and alter its course to one side. The advantage of the spinal puncture needle or other blunt-pointed needle is that one cannot penetrate important structures without having first encountered a feeling of resistance greater than that given by liver tissue itself. Likewise, when attempting to locate an abscess of the perihepatic spaces, the needle is inserted in the chest wall. If pus is present between the chest wall and the liver, pus will be encountered before the needle enters the liver. If no pus is encountered, direct the needle in the direction of the anterior or the posterior perihepatic space. This will require going through liver tissue. If no abscess is encountered in liver tissue, when the capsule is reached slight resistance will be felt. Being sure that no important structures can be at the point of the needle by carefully estimating the distance and direction of the needle, penetrate the capsule. The feeling of resistance against the needle is followed by a feeling of non-resistance as the needle enters the abscess cavity. This is very similar to that experienced in doing a spinal puncture as the needle penetrates the membranes and enters the spinal canal.

Aspirate thirty to sixty cubic centimetres of pus, depending upon the ease of aspiration, and inject the iodized oil. A smaller quantity of fluid should be injected than was withdrawn. It is necessary to know whether the iodized oil will sink or float upon the surface of the purulent fluid. The iodized oil used in the illustrations is heavier than water and the usual abscess fluid and will not mix with it but will sink to the lowest level.

The patient may now be placed under the fluoroscope or pictures may be taken for permanent record, with the patient turned so that the boundaries of the cavity will be determined as the iodized oil changes its position to reach the lowest level.

During this time the aspirated pus is being examined for pyogenic organisms. The character of the pus may clearly indicate that it is an amoebic



FIG. 4.—Abscess of the liver. After aspiration of three ounces of pus, one ounce of iodized oil was injected through needle. This very definitely determines its size, shape and boundaries.



FIG. 5.—Lateral view showing abscess with one ounce of iodized oil injected into the cavity. Its position in relation to the sternum and vertebra is definitely outlined. The shadow has an hour glass constriction. *D.* It is probable that the liver abscess has secondarily invaded the extra-peritoneal perihepatic space. This was an amoebic abscess.

abscess or that it is the result of a decidedly pyogenic infection. It is important to know, however, in case it appears to be an amoebic abscess, whether the amoebic pus has been secondarily infected. If it has been then incision and drainage will probably be required. If it is a sterile amoebic abscess as more than 80 per cent. will be, no further operative measures will be required beyond the continued aspiration of all pus available. However, at a later date one or more subsequent aspirations may be necessary. It is therefore desirable that one definitely localize the abscess and determine its size and shape as an aid to future aspirations. It is sometimes difficult to again locate a small liver abscess for aspiration although one may feel he knows quite well its general direction as revealed by a former aspiration. However, if the abscess cavity is injected with iodized oil at the first aspira-

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tion and X-rays are made in two planes, the cavity is definitely localized in its relation with other anatomical structures.

In exploring the liver or perihepatic spaces it is easier if three or more needles are used. The first needle being inserted and no abscess encountered, it is left in position. When the second needle is inserted and no abscess found, it also is left in place. By leaving the needles in place the direction and area explored are definitely known and it is much easier with the third needle to explore remaining areas of the right lobe.

Having located the abscess and by means of iodized oil definitely determined its boundaries, and having made smears to determine the presence of pyogenic organisms, effective treatment can now be rendered the patient. Should it be found to be an amœbic abscess, sterile as regards pyogenic organisms, aspiration of the abscess one or more times with intramuscular injections of emetine hydrochloride will probably be all that is required. Open drainage in case of sterile amœbic abscess is no more to be recommended than it is in tuberculous abscesses elsewhere. In each case secondary infection will almost certainly occur and prolonged suppuration will result.

If pyogenic organisms are present in smear or culture, incision and drainage offers the greatest hope. This should, as a rule, be done at once although in acutely ill patients aspiration of the cavity at the time of exploration may put the patient in better condition for a second stage a day later. However, delay in draining a suppurative process cannot be advised except in rare cases.

In searching the literature one is impressed by the fact that various prominent surgeons seem to be convinced that one single method of approach is superior to others. Some advise the abdominal route for all abscesses irrespective of their location, as the desirable one. Others feel that the lateral approach through the intercostal spaces is the only proper method. Even in the intercostal route some advise only going by the supraphrenic route rather than below the diaphragm, while others remain below the diaphragm entirely.

The efficient method of approach can be determined by a definite localization of the abscess and the route used which is the shortest, the least traumatizing to important structures and therefore the least shocking, and which will insure satisfactory drainage.

It would seem absurd to suggest that an abscess at the points D or E in Fig. 2 could be drained with the least trauma or that satisfactory drainage could be established through an abdominal incision. Neither would a posterior or even a low intercostal incision be satisfactory for draining an abscess at point F in Fig. 2, when it is evident that it is easily accessible through a small incision in the anterior abdominal wall.

It is true there may be only one satisfactory route of approach and that route can best be determined in the great majority of cases by definite visualization of the abscess cavity by means of some opaque substances such

as iodized oil and choosing the route which is the shortest, which establishes satisfactory drainage and which is least shocking to a seriously ill patient.

By careful localization of the abscess instead of an exploratory operation the 50 per cent. mortality rate now attributed to perihepatic abscesses should be materially lowered.

It may be that the exploring needle is an "unsurgical procedure" although I do not think so. But if it is, does it not seem better to have a live patient



FIG. 6.—Patient with perihepatic abscess. The exploring needle was inserted in the ninth interspace anterior axillary line. Pus was found in the anterior perihepatic space. Thirty cubic centimetres of pus withdrawn and twenty cubic centimetres of iodized oil injected through needle. The oil at once sank to the lowest level below the diaphragm (A). Patient lying flat on his back.

diagnosed or treated by the aspirating needle rather than a seriously shocked or dying patient who has received the benefit of a thoroughly surgical procedure?

SUMMARY

The exploring needle has a definite place in the diagnosis of hepatic and perihepatic abscess, and when used for injection of iodized oil the definite location, size and shape of the abscess can be determined. The site of the abscess is not entirely sufficient datum for successful treatment but the extent of the cavity in all directions is important.

DIAGNOSIS OF HEPATIC ABSCESS

The aspirating needle cannot be used with safety in the left lobe of the liver or left perihepatic spaces.

The exploring needle can be used without a general anæsthetic. In the acutely ill patient the procedure gives no appreciable shock and the subsequent incision and drainage, if indicated, can be by the route that is shortest and least shocking.

The spinal puncture needle or similar blunt needle adds to the safety of the procedure.

The aspirating needle is of value both in diagnosis and in treatment of amœbic abscesses of the liver or of those that have extended into the perihepatic spaces, provided secondary infection has not occurred. The presence of pyogenic organisms is an indication for incision and drainage.

There is usually only one satisfactory route of approach to an hepatic or perihepatic abscess and that route can be determined in the majority of cases by the definite localization of the boundaries of the cavity after injection of some opaque substance.

AN INVESTIGATION OF THE FUNCTIONS AND SYMPTOMS OF THE SURGICALLY DRAINED GALL-BLADDER*

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ONE rarely hears the contention today that cholecystostomy is the operation of choice in the surgical treatment of gall-bladder disease. It is common knowledge, however, verified by statistics from leading hospitals and surgical clinics, that this operation is still being performed. A certain number of these patients find their way back to the surgeon for unrelieved or recurrent symptoms, or for symptoms in which an estimation of the remaining gall-bladder as a total or contributing factor is highly desirable.

With these facts in mind, a number of patients who had cholecystostomy previously performed were recalled to the Jefferson Hospital for examination and study. Five of these had had their primary operation elsewhere. Their course since operation and present physical condition was determined and cholecystograms were made. The data presented were collected from thirty-six such patients and have been arranged under separate headings and presented in table form.

It was felt that the patients treated for empyema and common duct stones were of sufficient importance to warrant more detailed reports. These are shown, therefore, as distinct sub-groups.

Information on the patients that came to subsequent operations is likewise given in more detail.

Patients indicated as "Improved" in the table showing clinical results have all complained, at some time since operation, of belching and epigastric fullness of varying degree. Nine in this group have had one or more attacks of colic.

Cholecystography was chosen as the best available method of measuring gall-bladder functional capacity. One must bear in mind, as pointed out by its originator,⁶ that four essential steps are necessary before a shadow of the gall-bladder can be obtained by X-ray after the administration of an opaque substance. They are: (1) access to the liver for the substance; (2) its secretion into the bile; (3) access to the gall-bladder by the patency of the cystic duct; (4) sufficient concentration within the gall-bladder.

The oral administration of tetraiodophthalophenon was used in this investigation. It is known that vomiting and diarrhoea by diminishing absorption can introduce an error.⁶ All patients exhibiting these to any appreciable degree were discarded. Since discernible liver disease may interfere with secretion of the dye into the bile, one such patient was likewise discarded.

* Read before the Philadelphia Academy of Surgery, May 5, 1930.

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Excluding obvious liver disease the percentage of error in cholecystography by method used from failure of secretion of bile has been shown to be less than 1 per cent.⁶

LESIONS FOUND AT OPERATION

	Number	Per Cent.
Chronic cholecystitis Gall-bladder stones	32	88.8
* Empyema (gangrene)	7	19.4
* { Chronic cholecystitis Common duct stones Gall-bladder stones }	6	16.6
Chronic cholecystitis without stones	4	11.1

CLINICAL RESULTS

	Number	Per Cent.
Symptom-free	18	50
Improved	14	38.8
Unimproved	4	11.1

From all the splendid experimental work done on the gall-bladder its normal functions have been determined to be: (1) the storage of bile; (2)

	Gall-bladder Visualized		Gall-bladder Not Visualized			Normal Response	
	Number	Per Cent.	Number	Per Cent.	Total Number	Number	Per Cent.
Symptom-free	4	11.1	14	38.8	18		
Improved	2	5.5	12	33.3	14	1	2.7
Unimproved	1	2.7	3	8.3	4		
Totals	7	19.4	29	80.5	36		

the concentration of bile; (3) its expulsion on demand into the duodenum.^{4, 1, 2, 3, 5} The concentration is brought about by the mucosa through the absorption of water.⁴ Since the production of a cholecystogram clearly depends upon the concentration of an opaque dye in the gall-bladder,⁶ one

* Included in first group of chronic cholecystitis and gall-bladder stones.

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would expect, therefore, to find the mucous membrane an essential factor for this concentration. That this is true has been shown experimentally.⁷

The expulsion or out-flow of bile into the duodenum is due to the contraction of the smooth muscle within its walls.¹ This contraction may be brought about by the ingestion of fats, and also by other means not pertinent to this discussion.

Of the entire group comprising thirty-six patients, there are twenty-seven females and nine males. The average time since operation is forty-six

EMPHYEMA OF GALL-BLADDER

Case	Time Since Operation in Months	Symptoms	Subsequent Operations	Findings at Subsequent Operations	Cholecystogram
E. D.	40	Two mild attacks of pain	Refused operation	.....	"Gall-bladder not visualized."
E. M.	6	Pain, jaundice, fistula	Cholecystectomy, excision fistula	Chronic cholecystitis with empyema and gall-bladder stones, common duct stones	"Gall-bladder not visualized."
E. A.	38	Pain, gall-bladder fistula	Cholecystectomy, excision fistula	Chronic cholecystitis with empyema, cystic duct stone	"Gall-bladder not visualized."
H. F.	6	Symptom-free	None	.....	"Gall-bladder not visualized."
J. S.	36	Symptom-free	None	.....	"Gall-bladder not visualized."
E. S.	24	Epigastric fulness, belching	None	.....	"Gall-bladder not visualized."
M. G.	63	Indigestion, dizziness, Blood-pressure, $\frac{180}{90}$	None	.....	"Gall-bladder not visualized."

months. The longest period is 230 months and the shortest six months. The average morbidity period is twelve weeks.

All of the patients of empyema and the cases having common duct stones also had gall-bladder stones. From the empyema group two patients had subsequent cholecystectomies and one of these two had common duct stones as well. If the latter be excluded, it will be seen that none of the common duct cases, as such, came to subsequent operation. Only two patients in the empyema group are symptom-free: one thirty-six and the other six months after operation. Three of the common duct patients are symptom-free without secondary operation.

As pointed out previously, one known function of the gall-bladder is the

THE SURGICALLY DRAINED GALL-BLADDER

ability of its mucous membrane to absorb water and thereby concentrate its contents.⁴ The cholecystograms from the patients presented indicate that this function is entirely lost in 80 per cent. and impaired in 17.3 per cent. of the remaining 20 per cent. Only one, or 2.7 per cent., indicated normal function. This indicates very clearly that the function of concentration is severely impaired or completely lost in the surgically drained gall-bladder.

Obviously a gall-bladder must be visualized on a cholecystogram before any indication of its capacity or ability to empty can be obtained. It has been shown that severe injury to the gall-bladder resulting in fibrosis markedly inhibits its emptying time.³ Of the seven gall-bladders visualized in this series, five showed impaired contraction. These represent, however, only 13 per cent. of the entire group, making these findings of relatively little value.

COMMON DUCT STONES

Case	Time Since Operation in Months	Symptoms	Cholecystograms	Subsequent Operations
F. N.	9	Symptom-free	"Gall-bladder not visualized."	None
A. C.	41	Several attacks of colic with jaundice, symptom-free twelve months	"Gall-bladder not visualized."	None
A. G.	25	Two attacks of colic, symptom-free fifteen months	"Gall-bladder not visualized."	None
L. H.	62	No pain, occasional indigestion	"Gall-bladder not visualized."	None
A. S.	41	Symptom-free	"Gall-bladder not visualized."	None
E. M.*				Cholecystectomy

* See E. M. under Empyema of Gall-bladder

The size of the gall-bladders visualized on the cholecystograms is entirely within normal limits, which would indicate no appreciable loss in capacity in 19.4 per cent. of the patients. In all of the five patients that came to subsequent operation, however, the gall-bladders were shrunk and their volume capacity very definitely diminished, but these gall-bladders were not visualized on the cholecystogram. This may be explained by a difference in the degree of fibrosis of the gall-bladder walls, though we do not have sufficient evidence to substantiate such a claim.

Eighteen, or 50 per cent., of those studied have remained symptom-free. All of these gave cholecystograms indicating absent or impaired function. Clearly, these findings indicate little if any relation between function and symptoms in the externally drained gall-bladder.

The patients having subsequent cholecystectomies all had gall-bladder stones at the primary operation. There is absolute knowledge that in two of these cases all stones were not removed at this operation.

SUBSEQUENT ABDOMINAL OPERATIONS WITH FINDINGS

Case	Findings at First Operation	Course After Cholecystostomy	Time Between Operations	Reasons for Second Operation	Findings at Second Operation	Cholecystography	Operation
E. M.	Empyema and stones	Stones discharged through wound after leaving hospital	Six months	Pain, jaundice, pus draining from wound	Chronic cholecystitis with empyema, gall-bladder stones, common duct stones	"Gall-bladder not visualized."	Cholecystectomy
E. A.	Chronic cholecystitis and gall-bladder stones	Attacks of colic, residual pain, gall-bladder fistula	Thirty-four months	Pain, gall-bladder fistula	Chronic cholecystitis with empyema, fistula, cystic duct stone	"Gall-bladder not visualized."	Cholecystectomy
J. H.	Chronic cholecystitis, extensive adhesions from a previous abdominal operation	Symptoms not relieved	Fifty-two months	Unrelieved symptoms	Chronic cholecystitis	"Gall-bladder not visualized."	Cholecystectomy
W. L.	Chronic cholecystitis, gall-bladder stones	Symptom-free	230 months	Incisional hernia	Gall-bladder small, adhesions, walls thickened, no stones, yellow bile	"Gall-bladder not visualized."	Exploratory, cholecystotomy, repair of incisional hernia
H. H.	Chronic cholecystitis and stones	Improved, no colic, digestive disturbances	Twenty-seven months	Appendicitis	Chronic appendicitis, gall-bladder small, walls thickened, no stones, yellow bile	"Gall-bladder not visualized."	Exploratory cholecystotomy, appendectomy, herniorrhaphy

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SUMMARY

1. Thirty-six patients were studied by cholecystography at different intervals following cholecystostomy. One, or 2.7 per cent., gave a normal response. Thirty-five, or 97.3 per cent., showed absent or impaired function.

2. Three of seven visualized gall-bladders indicated normal emptying function.

3. Eighteen patients, or 50 per cent., have remained symptom-free, yet their cholecystograms indicate impaired function. Four of these were visualized—fourteen not visualized.

4. Three had a return of symptoms severe enough to necessitate subsequent cholecystectomy.* Two of these had stones left in the gall-bladder at their first operation.

5. Eighteen, or 50 per cent., have remained symptom-free and fourteen, or 39 per cent., are definitely improved.

6. Gall-stones were found in thirty-two patients, empyema of the gall-bladder in seven, and in six there were common duct stones. All cases of empyema and common duct stones likewise had gall-bladder stones. One had all three.

In conclusion, these findings indicate that: (1) cholecystography, being a test of function, is of no assistance in the evaluation of symptoms arising in a patient subsequent to cholecystostomy; (2) external surgical drainage of a diseased gall-bladder is not a means to a restoration of its normal function; (3) normal function of the surgically drained gall-bladder is not essential to good health and a symptom-free existence; (4) the surgically drained gall-bladder that fails to subsequently produce symptoms represents a healed-in lesion.

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* These patients had cholecystostomy performed elsewhere. We are greatly indebted to the members of the X-ray department of this hospital for their skillful coöperation.

GALL-BLADDER FUNCTION

WITH SPECIAL REFERENCE TO CHOLECYSTOGASTROSTOMY AND
THE ABSENCE OF ASCENDING CHOLANGITIS *

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IMPRESSED by the unsatisfactory results following either cholecystostomy or cholecystectomy, I suggested cholecystogastrostomy as a compromise operation in a paper presented to the Southern Surgical Association in 1923. The observation of twenty-one cases covering a period of ten years for the longest

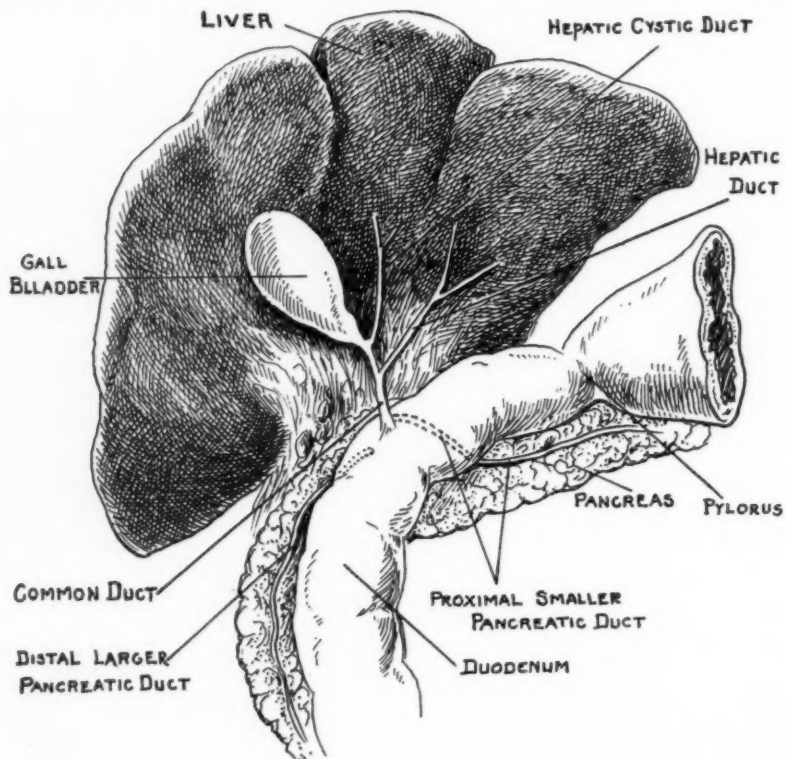


FIG. 1.—Diagrammatic outline of the liver and pancreatic ducts in the dog. Special attention to the two hepatic ducts: one to gall-bladder and one to join duct.

convinced me at that time that the bugbear of suppurative cholangitis or multiple abscess of the liver was not a sequence of this operation in the human being, although in animals, particularly the dog, it was constant. When one considers the difference in the food entering the stomach of man and that of the dog, and the consequent difference in the bacterial flora of the

* Read before the Alabama State Medical Association, April 15, 1930.

GALL-BLADDER FUNCTION

human stomach, which is relatively aseptic, while that of the dog is teeming with every sort of pathogenic and putrefactive bacteria, one can understand the wide divergence of necessity in the results. An even more important factor than the difference in the bacterial flora respectively of the two stomachs is the anatomic difference in that the gall-bladder in the dog through one of its two hepatic ducts communicates directly with the intrahepatic bile duct system; an open canal through which any gall-bladder infection in the dog by simple continuity involves the liver ducts.

Seven years ago, cholecystectomy was, as now, in ascendancy as the operation of choice in gall-bladder disease. One would conclude from the frequency of its surgical removal that it was not only a dispensable organ but that it was an unnecessary appendage of the liver, better out than in, being at most only a bile reservoir. These opinions in the light of our present meagre knowledge of gall-bladder function were and are grossly in error.

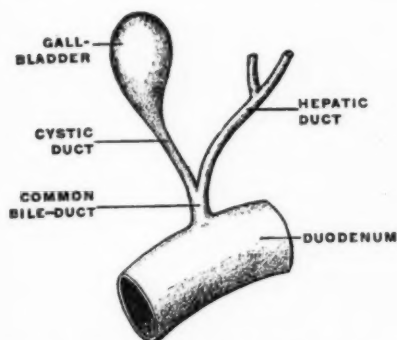


FIG. 2A.—Hepatic and cystic ducts of man.

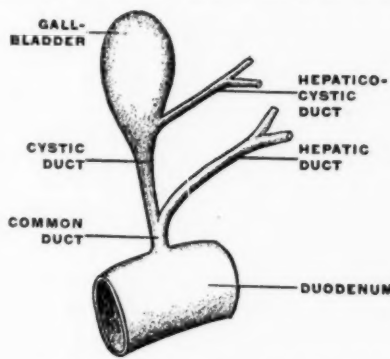


FIG. 2B.—Hepatic and cystic ducts of the dog.

At that time it was well known that in all gall-bladder infections there was a concurrent infection of varying degree of the intrahepatic tract and that the infection of the gall-bladder was but an intensified expression of the biliary duct infection. In the present state of knowledge of liver function and pathology it is just about as reasonable to do a cholecystectomy on a functioning, though infected gall-bladder, as to cut off the tail of a sick dog. Neither the urinary bladder nor the kidney is removed on account of infection nor because they happen to contain a stone, but were the urinary bladder removal easy and free from immediate danger it also would have participated in the onslaught of removing another apparently unnecessary organ of the human body. The end-results of cholecystectomy and cholecystostomy are an increasing rebuke to gall-bladder surgical treatment.

The enormous amount of research work to determine gall-bladder function other than its being a bile reservoir has resulted in valuable information. A study of its anatomy would presuppose a considerable functional activity of the gall-bladder; its profuse blood supply and the richness of its lymph follicles communicating directly to the liver cells; its ability to concentrate the bile twenty to thirty times that of liver bile; its estimated daily absorption

of bile ranging from 1200 cubic centimetres to 1500 cubic centimetres, the substances thus absorbed in addition to water are bile acids, bile pigment and lipoids, and in its absence this burden is of necessity assumed by the remaining biliary system. The gall-bladder is definitely concerned in fat metabolism, a disturbance of which causes the gall-bladder to take on more fat than its mucosa can absorb, and this excess fat is deposited on the wall of the gall-bladder as cholesterol; thousands of gall-bladders overburdened with fat metabolism have been removed because of this cholesterol deposit on the mucosa, which has been considered inaccurately a pathological condition, and described under the name of the strawberry gall-bladder. The assumption that in the human economy the gall-bladder was an unnecessary organ because

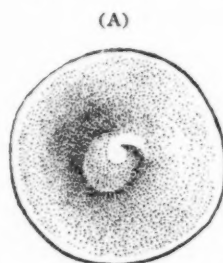


FIG. 3A.—The first fold of Heister. The commencement of the neck of the gall-bladder is marked by the first fold of Heister, which is a thin semilunar membrane narrowing the lumen to less than a third of its original diameter. The orifice is eccentrically situated. (After drawing of a specimen of Doctor Sweet.)



FIG. 3B.—Heister's illustrations of the neck of the gall-bladder and the cystic duct. They show that Heister's conception of the anatomy of these structures was clear.

it was found to be absent in many ungulates, ruminants, and rodents, that the grass and foliage feeding or the character of the food made it unnecessary is evidently in error, as in these animals it is not consistently absent; for example, in the ruminants the deer has none, while the sheep has; among the rodents, the rat is without and the mouse with a gall-bladder, the peccary has none and is a non-ruminant. It appears with more certainty that the absence of the gall-bladder is found in those animals of these groups, and some birds whose digestion is carried on continuously, or without marked interruption, a process which calls for the continuous flow of bile, there being no opportunity for storage, concentration or absorption. This variability emphasizes the morphological fact that the biliary bladder is only a modified portion of the hepatic duct system. One great surgeon says its absence is due to grass and foliage feeding, and it has been facetiously intimated that man go back to his primitive state and feed on weeds and leaves as Nebuchadnezzar of Bible lore. Would it not have been preferable for the cat and

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the lion to be used as examples, as these felines have bilobed gall-bladders, which probably explains the majesty of the lion, king of beasts, and the proverbial nine lives of the cat. Cholecystectomy has been and is the most attractive feature in gall-bladder treatment. In the majority, the removal apparently has not been harmful, especially in those whose livers were capable of taking on a compensatory hypertrophy in their biliary systems, notably in the common duct which markedly dilates as a result of the state of spasm of the sphincter of Oddi following cholecystectomy—nature's plan of supplying its need for a bile reservoir. Observation of even as self-evident a fact as this is misconstrued; an instance of how far wrong such an interpretation may be is found in the statement by one observer that better drainage of the biliary system after cholecystectomy occurs on account of the increased size of the common duct which follows this operation. The most pertinent conclusion after cholecystectomy is that something better is needed, as approximately 30 per cent. have recurrence of all pre-operative symptoms and more than before; the surgical relief of which is vastly more difficult.

Ascoff states that if removability of an organ were proof of want of function, then the teeth, spleen, and many other parts of the body should be considered functionless by the same assumption.

Held and Goldbloom observe that the less dispensable an organ is the greater reserve it has, so that the liver, heart, kidneys, and lungs may become quite chronically diseased with but few signs or symptoms, even the finest functional tests failing to reveal the pathology in some instances until after the organ has broken down entirely.

Crile has stressed this sudden breaking down of the liver function following operative trauma. Extreme shock repeatedly, and death rarely, has followed withdrawing the drains after cholecystectomy. It should be noted that the dispensable organ, when it has ceased to function as a result of disease, and in the chronic types without symptoms, may menace the whole body by being either the seat of focal infection, or by direct extension of disease, and the incidence of cancer. It is here the necessity for removal is apparent and without criticism.

With reference to the emptying of the gall-bladder, there is the widest difference of opinion. The extreme from those who maintain that no bile goes from the gall-bladder through the cystic duct into the intestine to those who contend that it periodically empties its concentrated contents through the cystic duct and the sphincter of Oddi into the intestine, and that this periodic emptying depends on varying factors, the intake of food, the kind of food, diaphragmatic respiration, duodenal activity, siphonage; also drugs, notably pilocarpine, pituitrin, and magnesium sulphate. Even in cholecystography, the one assumes its reduction in size results from emptying, the other from rapid absorption; the one the different position of stones after a fat meal by emptying; the other by absorption. One observer has seen the gall-bladder contract during operation, and another is equally certain that he has never seen either contraction or elastic recoil. One maintains the activity of

the diaphragm is the main factor in emptying the gall-bladder, while another proves this an error by the gar pike which has no diaphragm, and yet its gall-bladder empties similarly to other animals with diaphragms.

Halpert has proven that the chief function of the muscular coat of the gall-bladder is to prevent overdistention and to adjust its size to its varying contents; that bile or any other fluid injected with slight pressure into one of the bile ducts above the duodenal portion fills up first the hepatic and common

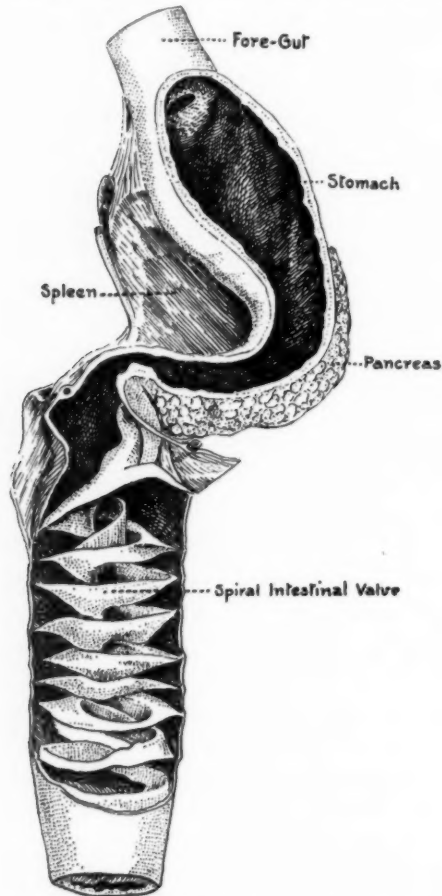


FIG. 4.—Spiral intestinal valves in the dogshark.

ducts, then the cystic duct, and finally the gall-bladder. Fluid or bile from the gall-bladder does not enter the duodenum however until the gall-bladder becomes greatly distended. If there is a small hole in one of the bile ducts, then the filling of the gall-bladder from the ducts does not occur, the fluid passing through the hole, none going to either gall-bladder or duodenum. A hole in the gall-bladder, though very small, even a needle prick, permits abundant escape of bile indicating pressure within the ducts. Halpert has also demonstrated rhythmic contractions of the gall-bladder occurring from

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one to three per minute in frequency, having from 2 millimetres to 46 millimetres with a displacement of from 0.1 to 2.3 cubic centimetres of Locke's solution. Stasis in the gall-bladder is due to an abnormal composition of the bile from a disturbed function of the liver or to an altered power of absorption within the gall-bladder mucosa, therefore the processes leading to stasis may be either in the gall-bladder or in the liver or in both the liver and the gall-bladder.

The study of these disturbances of function or of altered physiologic activity common to both the gall-bladder and liver are cited and stressed as

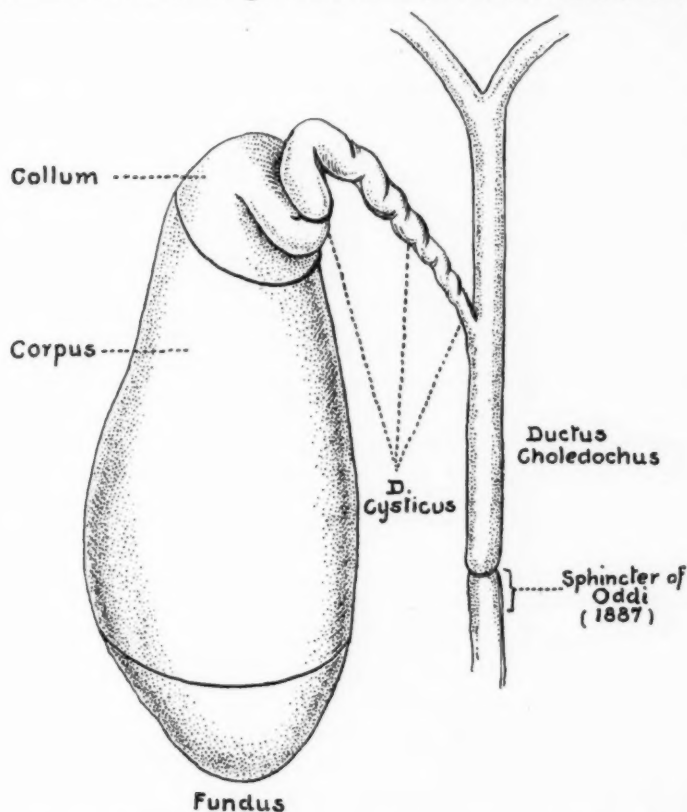


FIG. 5.—Diagram of the extrahepatic bile ducts and the gall-bladder. They form a Y-shaped communicating vessel of which the ductus choledochus is the stem, the common hepatic duct the one branch and the cystic duct the other. (After B. Halpert, *Arch. of Surgery*.)

added proof of liver and gall-bladder interdependence physiologically and pathologically, that the incidence of infection is common and concurrent in both, and of the necessity of recognizing the gall-bladder, biliary ducts and liver as a unit in future research.

Under Crile's electrochemical hypothesis, cholecystogastrostomy should balance the potential of the acid and the alkali reserve in the system. In the pathology and healing process of gastroduodenal ulcers, Goyena stresses the great importance of the equilibrium of the acid and alkaline factors of the organism.

A perplexing confusion, even chaos, exists in experimental research on this subject; some failures, few though they be, are from faulty methods and illogical deductions, which confuse rather than clarify. With greater frequency, and even more disturbing, are the contradictory results obtained by equally efficient research workers, and here it seems that there has been entirely left out of the equation the difference in the physiologic and pathologic status of the varying types of vertebrates, the difference between either the chemical secretion or the bacterial content of the same organ in different animals, of the state of health, or of the functional activity differing as it does in different individuals of the same species, and under varying conditions in the same individual of any species at different periods of time. Without a proper understanding and correct evaluation of those fundamental differences, not only of types but of conditions in the same type, disparity in result is a logical sequence.

The anatomic structure of the cystic duct permits an easy inflow and a difficult exit of bile, some observers contending that no bile passes from the gall-bladder through the cystic duct. The Heisterian folds of mucosa produce one-way valves and are competent to the water test when the gall-bladder is filled. It is interesting to note that the spiral folds such as are found in the cystic duct are also present in a modified form in the *valvulae conniventes* and the crescentic folds of the large intestine. Similar spiral mucus folds are encountered in the higher vertebrates, being especially well developed in the large intestine of rodents, ruminants, some fishes, and birds. The S-shaped turn at the neck of the cystic duct and the conical shape of the duct itself, narrowing as it runs its course to join the hepatic duct, is another factor interfering with the passage of the bile from the gall-bladder. These anatomic structures fulfill the same purpose after cholecystogastrostomy that the oblique entrance of the common bile duct through the duodenum and the ureter through the bladder does in inhibiting ascending infection. The rôle of ascending infection in both the kidney and bile tracts is a negligible factor; it is generally recognized and accepted that infections in the biliary and urinary system for the greater part are hæmatogenous in origin.

Choledochoduodenostomy is a standard surgical procedure done under certain definite indications, and attention has not been called to the danger of ascending infection as a sequence nor have any cases been reported of the incidence of cholangitis or suppurative hepatitis following this operation, and in this procedure there is a direct communication between the biliary duct system and the duodenum.

Attention is again called and emphasized in regard to the failure of research workers in animal experimentation in recognizing the difference in the anatomic structure of the human gall-bladder and that of the dog, the most used animal in experimental research in gall-bladder and liver surgery. There is no parallel or similarity in the operation of cholecystogastrostomy on the dog and human being as a proof of secondary ascending infection, cholangitis or multiple abscess of the liver, etc., since the dog has the

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hepaticocystic duct, an accessory biliary canal, a direct communication between the gall-bladder of the dog and his intrahepatic biliary ducts, which is not found in the human being. The fact that the dog has another hepatic duct similar to man which joins with the cystic duct to form the common bile duct perhaps has caused this main factor of a direct communication between the gall-bladder and the intrahepatic biliary ducts of the dog to have been overlooked, and to have been left out of the deductions from such work; it certainly has not been mentioned in the many papers on this subject coming under my notice. There is still another anatomic difference between the dog in that the pancreatic and the common bile ducts do not unite—the dog having no Ampulla of Vater—but enter the duodenum below the entrance of the common bile ducts by two canals each the prototype of Santorini and Wirsung respectively, and are called the proximal smaller and distal larger pancreatic ducts.

THE ABSENCE OF AN ASCENDING INFECTION IN HUMAN BEINGS IS ACCOUNTED FOR BY

1. Anatomic structure of the cystic duct.
 - a. Heisterian folds of the mucosa, producing one-way valves which are "competent to the water test."
 - b. S-shaped curve of neck of cystic duct.
 - c. Conical shape of duct narrowing to a very small opening at its junction with the hepatic duct.
 - d. Fundus of the gall-bladder being the most dependent part of the biliary duct system, lower than the Ampulla of Vater.
2. The constant intra-biliary duct pressure.
3. Relatively sterile food and low grade bacterial gastric content.

INDICATIONS FOR CHOLECYSTECTOMY

1. Non-functioning gall-bladder.
 - a. Atrophic or contracted gall-bladder.
 - b. Irreparable cystic duct occlusion.
2. Cancer of gall-bladder.
3. Gangrenous cholecystitis.

INDICATIONS FOR CHOLECYSTOGASTROSTOMY

1. Common duct obstruction in the poor surgical risks.
2. Residual hepatic duct stones.
3. Chronic obscure jaundice.
4. Extrahepatic duct obstruction.
5. Perforation of the gall-bladder.
6. Perforated stomach ulcer.
7. Gastric and duodenal ulcer.
8. Jejunal gastro-enterostomy ulcers.
9. Acute pancreatitis.
10. Acholia following cholecystostomy.

INDICATIONS AND CASES OPERATED ON, JAN. 1, 1926 TO JAN. 1, 1930

Cholelithiasis with colic	6
Cholelithiasis and empyema of gall-bladder	2
Suppurative cholelithiasis with jaundice	2
Suppurative cholecystitis with jaundice	3
Rupture of gall-bladder (Cholecystitis)	1

FRANCIS G. DuBOSE

Acute pancreatitis with jaundice	1
Chronic obscure jaundice and ascites	1
Gastric ulcer	4
Duodenal ulcer	3
Obstructive jaundice	
Carcinoma of pancreas	1
Carcinoma of liver	1

CASES PREVIOUSLY REPORTED

Operations 1912 to 1926	32
Operative recoveries	30
Recurrence of symptoms	3
Re-operation for recurrence	3
Cured by re-operation	3

CASES IN THIS SERIES

Operations 1926 to 1930	25
Mortality	0
Recurrence of symptoms	0
Total cases	57
Total mortality	2 or 3.5%
Total recurrence	3 or 5.2%

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CHOLECYSTECTOMY WITHOUT DRAINAGE*

BY RUSSELL S. FOWLER, M.D.

OF BROOKLYN, N. Y.

THE writer made a study of this subject in 1924, at that time having omitted drainage in eighty-one cases.† Since then drainage has been omitted in other cases bringing the total up to 240 cases. Of these cases forty-six were males, 194 were females.

All cases showed evidence of chronic inflammation. They have been classified, however, according to the most prominent aspect present at the time of operation.

Cholecystitis catarrhalis acuta	43 cases.
Cholecystitis catarrhalis chronica	18 cases.
Cholecystitis acuta	35 cases.
Cholecystitis chronica	144 cases.

Adhesions were present in all cases, varying from slight adhesions of the ampulla to the duodenum to extensive adhesions involving the fundus as well. Enlargement of the gland at the upper portion of the cystic duct was always present. Microscopic section was made in each case.

Stones were present in about one-half of the cases. Whether stones are present or not is immaterial for they are but one of the ways in which the inflammation expresses itself.

Additional lesions were present in some cases; several of these were of special interest, one a curious lesion of the pancreas which showed a uniformly hard and large pancreas with yellow shot-like infarcts; one a cystic disease of the liver in which the liver presented the appearance of being filled with shot, there being numerous small black shot-shaped and shot-feeling areas which on incision yielded clear serum; one a case of sclerosis of the pancreatic artery but without general arteriosclerosis; one a case operated early in pregnancy; three cases showed papilloma of the gall-bladder; one a calcification of the gall-bladder; one a biliary sinus.

Additional operations were done in many cases. In 177 cases appendectomy was done as well as cholecystectomy. One hundred and seventy-three of these cases showed chronic inflammation, three subacute inflammation, and one an acute inflammation. It is my practice to take out the appendix in all except the very acute gall-bladders. In forty-five cases the appendix had been removed at a previous operation. In eighteen cases no attempt was made to remove the appendix. In some cases associated operations were done for the following lesions: Nephroptosis, four; epigastric hernia, one; umbilical hernia, three; inguinal hernia, two, one case bilateral; hepatitis, one; cirrhosis of liver, one; sebaceous cyst, one; duodenal ulcer,

* Read before the Brooklyn Surgical Society, November 6, 1930.

† Cholecystectomy without drainage. *Am. Jour. of Surgery*, New Series, vol. v, No. 1, pp. 8-14.

five; diastasis of rectus muscles, one; hæmorrhoids, one; ovarian cystoma, two; Mullerian cyst, one; salpingitis, two; cystic ovary, two; prolapsus uteri, five; retroversion, seven; cystocele, one; lacerated cervix, two; lacerated perinæum, nine; adhesions (other than gall-bladder adhesions) resulting from previous operations, omental, fifteen; intestinal, three; old peritonitis, two; adhesions about appendix, three; adhesions about ovary, two.

Hospitalization.—The longest stay in the hospital was seventy-eight days, a case of advanced myocarditis. The shortest stay was thirteen days. Omitting the deaths, the average stay was sixteen days. It is my practice to keep patients in the hospital until they are strong enough to care for themselves; occasionally a patient will insist on going home as soon as he is able to walk about, and more rarely, some will wish to overstay their time.

Wound Healing.—Six of the 240 cases are omitted from consideration in this regard as death occurred within ten days post-operatively, leaving 234 cases for consideration. In no case was there any escape of bile through the wound, nor any bile discernible in the wound discharge during any of the wound complications.

Primary union, 223 cases. Wound complications, eleven cases classified as follows: Serum, trifling in amount, one case; serum and later pus, two cases; more pronounced infection but not severe, four cases; hæmatoma, superficial, one case; deep, one case; wound rupture, two cases.

Post-operative Complications.—Cases considered 240, of which eight died. One hundred and eighty-four cases showed no untoward symptoms. In addition to the wound complications already noted there occurred twenty-eight respiratory complications: Sore throat, three cases; slight cough, seventeen cases; pleurisy, one case; pneumonia, seven cases, one of which occurred three days after the patient left the hospital. Vomiting severe enough to be noted, six cases, one of which showed vomiting of blood, a case in which a gastro-enterostomy had been done for associated duodenal ulcer and blood was noted in the vomitus once; of the six cases one vomited so excessively as to cause wound rupture. Other complications: Phlebitis, three cases; involuntary defecation, one case; chill following catheterization, one case; prolonged and severe shock, one case; abscess in buttock, one case. Four cases subsequently developed ventral hernia.

Of the deaths one was a sudden death without premonitory symptoms, the patient being found dead in bed eight days post-operatively. This was a case of chronic cholecystitis without stones and subacute appendicitis in an otherwise healthy individual. Three cases, two chronic and one acute cholecystitis, died of pneumonia, two on the fourth day, one on the seventh day post-operatively. One acute cholecystitis died of shock and pneumonia, two days post-operatively. One chronic cholecystitis developed intestinal paresis for which an enterostomy was done, succumbing on the sixth day post-operatively. This case showed no evidence of bile leakage or peritonitis, but did have an enterospasm. One chronic cholecystitis died of wound rupture and its accompanying shock on the eleventh day after the original operation. One chronic cholecystitis died of pneumonia twenty-

CHOLECYSTECTOMY WITHOUT DRAINAGE

two days post-operatively, a very obese woman who had a most stormy course with final wound rupture. On resuturing the wound no peritonitis or escape of bile, or lesion other than that caused by wound rupture was discovered. The writer thought there was an obscure lesion of the pancreas, perhaps a beginning carcinoma, but with this the consultant entirely familiar with all the facts could not agree.

Temperature Range After Operation (234 cases considered).—The average lowest and highest temperature for each of the first three days post-operative was: first day, lowest temperature, 99.3°; highest, 100.8°; second day, lowest temperature, 99.1°; highest, 100.3°; third day, lowest temperature, 98.7°; highest, 99.8°. The average of fifty temperatures of cholecystectomy with drainage was 99° F. for fourteen days post-operative. This temperature study was made in connection with the use of the Fowler position after operations upon the upper abdomen. It was found that the temperature average was lower in cases in which the Fowler position was used. This point was utilized in a paper read before the International Congress in London in 1914, the study showing that infections through the lymphatics are less prone to occur after operations upon the upper abdomen if the patients are placed in the Fowler position.

The temperature range does not seem to be influenced to any great extent by the omission of drainage. As a matter of fact the temperature after cholecystectomy depends upon two factors, the character and amount of infection present, and the delicacy with which the operation is performed.

Final Results.—Eight cases died, 3 1/3 per cent. Seventeen cases have not reported since they were discharged from the hospital; 196 cases report themselves well for periods varying from three months to eight years after operation; nineteen cases reported symptoms of one kind or another at periods varying from three months to seven years post-operatively.

I think we should omit from consideration all cases in which less than a year has passed as I find that many cases have symptoms of one kind or another, mostly up to three months after operation, though sometimes as long as a year. These symptoms take the form of a mild indigestion, loss of appetite and associated symptoms due to the condition of the liver itself, as in so many gall-bladder cases there is passive congestion with its accompanying inability to care for certain foods and large quantities of food. I have not worked out the exact number of cases which require instructions in diet, and more particularly limitation in the amount of food taken, but, roughly speaking, would estimate the percentage at about 25. The liver in gall-bladder disease cannot care for an excessive amount of food; overeating must be warned against. Cases presenting slight symptoms yield readily to dietetic measures.

Omitting the cases in which the reports are less than a year, eighty-one cases (of which seventy-six report themselves as well and five report themselves as having mild symptoms) and those in which no report has been received, seventeen cases, and the eight deaths, leaves 134 cases of which 120 or 89.6 per cent. report themselves well from one to eight years post-

operatively; eight cases or 5.9 per cent. report mild symptoms from one to four years post-operatively; six cases or 4.5 per cent. report either severe symptoms or no improvement one to seven years post-operatively.

Comparison of Ectomy with and without Drainage.—Wound infection seems to be at least as common with drainage as without. The same may be said of hæmatoma. The writer's impression is that there is a slight difference in comfort in favor of those cases which are not drained. Comfort following operation bears a distinct relation to the skill used in operating and in caring for the wound afterward.

As to the final result, we have for comparison 543 cases of cholecystectomy with drainage, of which fifteen died, a mortality percentage of 2.7, compared with 240 cases of cholecystectomy without drainage of which eight died, a mortality percentage of $3\frac{1}{3}$. The mortality percentage is, of course, in favor of cholecystectomy with drainage. This is the more marked when we consider that cholecystectomy without drainage is done in the simpler cases.

Comparing the late results we have 406 cases of cholecystectomy with drainage with reports available one year or more post-operatively. Of these 365, or 94.8 per cent., reported themselves as being well; ten cases, or 2.5 per cent., reported themselves as having mild symptoms; eleven cases, or 2.7 per cent., reported themselves as having severe symptoms.

Comparing the above percentages with a similar analysis of 134 undrained cases of which reports are available from one to eight years post-operatively we have a marked difference in each class in favor of the cases which have been drained, and this again is the more remarkable as the drained cases undoubtedly showed more advanced pathology.

In view of the favorable statistics which this series of cholecystectomy with and without drainage for acute and chronic gall-bladder disease presents 783 cases with 23 deaths, a mortality percentage of less than 3 per cent., the writer wishes to say that while the common duct was explored in practically every case, this series does not include cases in which drainage of the common duct by T tube was done. Exploration of the common duct through the stump of the cystic duct does not seem to increase the mortality. Choledochostomy, however, with incision of the duct, removal of stones, cleansing of the duct and T-tube drainage raises the mortality about 1 per cent. This is not to be wondered at as such cases, having had their infection for a long time, show more damage to the liver.

In the last thousand cases of cholecystectomy, choledochostomy with T tube was necessary in ninety cases of which eleven died, a mortality percentage for cholecystectomy plus choledochostomy of 12.2 per cent.

When we find, as we do in this study, that in a series of 240 cases the percentage of deaths is greater than in a very much larger series of drained cases more severe in character, and when we find that in the analysis of the final results the drained cases show a considerable superiority in percentage of cures over the undrained, we must conclude that in spite of the temptation not to drain, it is wiser to drain.

SPLENECTOMY FOR HÆMORRHAGIC PURPURA OF CHILDREN*

BY FRED W. RANKIN, M.D., AND RICHARD S. ANDERSON, M.D.
OF ROCHESTER, MINNESOTA

FROM THE MAYO CLINIC AND THE MAYO FOUNDATION

THE removal of any organ from an extremely young child is a formidable procedure under any circumstances, and often is not successful. Nevertheless, the literature is replete with reports of extremely hazardous procedures, such as resection of the colon for intussusception, operations on the stomach for obstruction, and even removal of kidney or spleen under disadvantageous circumstances, with successful results. The necessity of performing splenectomy on a child aged four years prompted us to review the literature on this subject. We found that the spleen had been removed with favorable results from two other patients slightly younger than the one we had operated on. The subsequent satisfactory improvement in our case seemed to warrant a report of the case in detail.

REPORT OF CASE.—A boy, aged four years and two months, was brought to the clinic May 27, 1930. There was no history of "bleeders" in the family. During the last year the patient had had nosebleed, and bleeding from the gums. He also had had purpuric eruptions over the body; at times they had been diffuse, covering almost the entire body. The patient was easily bruised, and cut areas would bleed for several minutes. Tarry stools had been noted; the last hæmorrhage had occurred two months before his admission to the clinic.

General examination revealed anæmia graded 2, and large, bluish spots on the legs, arms and ears. The mucous membranes were pale and covered with petechial spots, as were the tonsils, which were small. The spleen was palpable, graded 1. The liver was enlarged, graded 2, and palpable below the costal margin.

The urine was acid in reaction; it did not contain albumin or sugar. The specific gravity was 1.030. The microscopic examination was negative. May 28 the hæmoglobin was 53 per cent.; erythrocytes numbered 3,930,000; leucocytes, 3,900; lymphocytes, 41 per cent.; large mononuclear leucocytes, 2 per cent.; transitionals, 3 per cent.; neutrophils, 46 per cent.; eosinophils, 3 per cent.; and reticulated cells, 0.9 to 0.8 per cent.; anisocytosis and poikilocytosis were present, and there was slight basophilic stippling and mild polychromatophilia. Platelets numbered 30,000 to 40,000. The coagulation time was fourteen minutes (Boggs); the bleeding time was one hour on one occasion, and forty minutes on another. May 30 the calcium coagulation time was seven minutes; there was no retraction at the end of twenty-two hours. The blood was in group 4. At this time platelets could not be found. Prothrombin time was 3 drops in ten minutes, 5 drops in twelve minutes, 7 drops in twenty minutes, 2 drops in ten minutes, 4 drops in twelve minutes, 6 drops in fifteen minutes, and 8 drops in twelve minutes. Erythrocytes numbered 4,260,000 and leucocytes 3,800. A röntgenogram of the thorax was negative. A diagnosis of hæmorrhagic purpura was made. The patient was in good condition and transfusion of blood was not necessary.

Splenectomy was performed June 6. The spleen, which was twice normal size, was removed without difficulty. The liver was larger than normal and had sharp edges.

* Submitted for publication October 28, 1930.

RANKIN AND ANDERSON

The gall-bladder was normal. The spleen was firm and pink; it weighed 60 grams and there was an increase in the number of malpighian bodies.

The platelets rose to 68,000 soon after operation. The erythrocytes numbered 3,520,000; the coagulation time was six minutes, and the bleeding time, twenty-five minutes. The hæmoglobin was 40 per cent. Platelet counts were made daily and the results were as follows: 68,000, 48,000, 34,000, 24,000, 28,000, 70,000, and 94,000.

Convalescence was uneventful except for slight bleeding from the nose. When the patient was dismissed from observation, June 19, the platelet count was 84,000, the hæmoglobin was 60 per cent., the erythrocytes numbered 3,500,000, and the leucocytes numbered 4,900. The coagulation time was five minutes, and the bleeding time was ten to twenty minutes. The purpuric spots had disappeared. There was no bleeding from the gums or any other source. July 29, 1930, the patient's mother wrote that the child was doing nicely; there was no evidence of bleeding.

Diagnosis.—Hæmorrhagic purpura indicates the spontaneous extravasation of blood into or under the skin and mucous membrane of the body. It is a symptom common to many diseases of diverse character and is not a disease in itself. Its etiology is uncertain but the condition, characterized by bleeding and associated with marked reduction in blood platelets and disturbance in blood coagulation, is thrombopenic purpura. The condition was first distinguished from other forms of hæmorrhagic disease by Werlhof, in 1781, and is sometimes even now termed "Werlhof's disease." According to Clough, it is probably dependent on constitutional abnormality of the bone marrow and in some cases there may be a hereditary tendency. The work of Duke shows the close relationship of the platelets to the bleeding time and clot retractility. Some authors stress the close parallelism between the number of platelets and the clot retractility much closer than that between the platelets and bleeding time. Koster noted the increased phagocytosis of platelets by endothelial cells. He also noticed dysfunction in the formation of the platelets and increased permeability of the capillary walls.

The primary cause of hæmorrhagic purpura may be an infection or a toxin which affects the spleen or other lymph tissues, or it may be due to some abnormality of the bone marrow. Other factors, such as increased permeability of the capillary walls, some interference in the production of normally functioning platelets, and increased destruction of platelets may occur. On examination of patients suffering from this condition, one usually finds only bleeding and anæmia.

A good history and a study of the blood will clinch the diagnosis. Data concerning the blood are: (1) increased bleeding time, (2) decreased platelet count, (3) a non-retractile clot, and (4) normal or slightly increased coagulation time. There is positive reaction to the Rumpel-Leeds test. The blood picture during periods of bleeding shows outstanding reduction in blood platelets, usually less than 60,000, and sometimes less than 10,000. The blood may show evidences of post-hæmorrhagic secondary anæmia which may become extreme. There is usually regeneration of erythrocytes, and polychromatophilia may be present. The coagulation time may be normal or slightly increased. The clot is abnormal in its failure to retract in the

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usual manner; the non-retractility is due to the lack of blood platelets. In hæmophilia there is a normal platelet count, a normal bleeding time, and prolonged coagulation time, but there are not many diseases that may be mistaken for hæmorrhagic purpura, especially if one studies the blood.

The chief indications for splenectomy in hæmorrhagic purpura have been pointed out by Giffin, Reuben and Clamon, Gregory, and others. After a correct diagnosis has been made, one is justified in performing splenectomy.

The reticulo-endothelial system seems to play a part in hæmorrhagic purpura. Aschoff described this system many years ago. One particular function of it is to devour the used-up erythrocytes, leucocytes, and the platelets of the circulating blood, and to metabolize them. Such cells are found in the sinuses of the lymph-nodes, the blood sinuses of the spleen, the capillaries of the lobules of the liver, and the bone marrow. Inasmuch as the reticulo-endothelial cells get rid of the jaded or excessive blood platelets, it is logical to assume that in a disease such as hæmorrhagic purpura, in which a low platelet count is a prominent feature, some part of this system is overactive. If the overactive cells are largely limited to the spleen, its removal would promise immediate good and probably permanent results. The bleeding time is prolonged and is directly proportional to the degree of reduction of platelets. There is diminished capillary resistance which is shown by the Rumpel-Leeds test. This test is carried out by applying a blood-pressure cuff to the arm at the mean blood pressure for five minutes. The test is positive if, within a few minutes after removal of the cuff, purpuric spots appear on the arm below the cuff. Profuse spots and spots of large size (1 centimetre in diameter) are almost pathognomonic of hæmorrhagic purpura.

This condition may go on for some time, or death may occur from hæmorrhage within a few weeks of the onset. The first attack usually subsides after one to three months and there may never be recurrence of bleeding. In most cases, the condition persists and runs a remittent or intermittent course. Remission is usually associated with a rise in platelets. Remission may last for a few weeks or for many years. During these intervals there is often a definite reduction in platelets, but not to the extent of causing bleeding. Purpuric eruptions are absent in some cases. The bleeding may be limited to a single source, for instance, the nose or bowel.

Differential diagnosis depends on the blood changes which are characteristic of hæmorrhagic purpura as follows: (1) diminished platelets, (2) prolonged bleeding time, (3) normal coagulation, (4) non-retractile clot, and (5) the reaction to the Rumpel-Leeds test.

The relation of decreased blood platelets to hæmorrhagic purpura is well recognized. Whether the decrease in blood platelets is due to the failure of the megakaryocytes of the bone marrow to form new platelets or to overactivity of the reticulo-endothelial cells to destroy them is still an unsettled question. The general opinion would seem to favor the theory that the blood platelets are formed in normal numbers but are destroyed by overactive

phagocytosis in the spleen and other parts of the reticulo-endothelial system. Therefore, the severity of the bleeding in hæmorrhagic purpura would seem to depend on: (1) thrombocytosis; (2) the extent to which certain cells of the reticulo-endothelial system engaged in thrombocytosis are distributed in the spleen, liver, bone marrow, and lymph-nodes, and (3) permeability of the capillaries to the circulating blood. The third of these factors has not been thoroughly investigated.

Treatment.—Unquestionably, splenectomy is the most satisfactory treatment for purpura of this type. Splenectomy for the condition has been performed at The Mayo Clinic in forty cases, with results which obviously justify the procedure as the wisest therapeutic measure (tabulation). The earlier the operation is performed in the course of the disease, the better are the results. It may be asked whether operation is contra-indicated in the

TABULATION

Results in forty cases of hæmorrhagic purpura subjected to splenectomy at The Mayo Clinic

Age, years	Cases	Male	Female	Results (no deaths)		
				Good	Fair	Poor
0-16.....	12	3	9	12		
16-30.....	18	6	12	15	3	
30-50.....	9	3	6	8		1
50-60.....	1	1		1		
Total.....	40	13	27	36	3	1

acute stage of the disease, that is, when the patient is having hæmorrhages. In such a case, it would probably be better to give two or three transfusions to see if the patient improves. If the bleeding continues, one would be justified in proceeding with splenectomy. On the other hand, if the patient improves following blood transfusions, one should wait until the risk of operation is lessened before performing splenectomy. Whipple and Spence have stated that splenectomy is definitely contra-indicated in acute cases, and Giffin, Reuben and Clamon, and others have stated that the acuteness of the condition is not a safe guide. There are patients who no doubt do better after having received pre-operative treatment, such as transfusions and intravenous injections of calcium lactate, or calcium chloride, but this depends entirely on the case and a study of the blood. If the platelet count is extremely low, and the bleeding time is very much prolonged, in the presence of marked secondary anæmia, it is advisable to give transfusions of blood and to use any other precautionary measures that may help in a particular case. The only effective method of controlling bleeding in severe cases, according to Clough, is transfusion of blood. Relief is usually temporary, lasting from three to four days, which is the probable average life of the platelets. In some cases unaltered blood seems to be more effective than citrated blood. Preparations, such as serums, thromboplastic substances, calcium salts, and so forth, usually have little if any effect.

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It is the belief of Giffin and Holloway that splenectomy is necessary in order to obtain sustained relief. In almost all cases bleeding stops promptly and there is usually a marked rise in the number of platelets. In a few weeks or months the platelet count again falls but in most cases bleeding does not occur. It is not certain just how removal of the spleen stops bleeding. Clough stated that the spleen possibly has been actively destroying platelets or that it has been exercising an inhibiting influence over the formation of platelets in the bone marrow. This part of the question is unsettled. Evans found that there is a rise in platelet count following splenectomy for such different causes as trauma, acholuric jaundice, and splenic anaemia.

Prognosis.—The prognosis is good. The forty patients on whom splenectomy was performed at The Mayo Clinic are living and in good health. There is no tendency to bleeding. It seems that the best results are obtained in cases of children and that the prognosis is more favorable when the spleen is removed early in the course of the disease. The greatest value in the study of prognosis is the summarizing of end-results. This has been carefully done by such men as Williamson and Spence who found that the prognosis and end-results were good.

An important point in diagnosis, treatment and prognosis is to decide whether the disease is chronic and recurrent, or whether it is the acute fulminating type. The chronic type is promptly and permanently cured by splenectomy. There is an immediate rise in platelets and a return of the bleeding time to normal. The acute type does not respond satisfactorily to such a procedure. The condition may come on suddenly without any history suggestive of it. Repeated transfusions may be necessary. One patient at The Mayo Clinic was given twelve transfusions in forty days. In view of the fact that splenectomy cures, it is evident that the major disturbance of the reticulo-endothelial system is localized in the spleen. In Whipple's review of eighty-one cases, seventy-three were of the chronic type, in six of which death occurred, and eight were of the acute type, in seven of which death occurred.

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END-RESULTS IN RADICAL OPERATIONS FOR CARCINOMA OF THE PERIAMPULLAR REGION OF THE DUODENUM*

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ALTHOUGH most authors agree in that carcinoma of the periampullar region is a rare disease, a sufficient number of operations have been done both with and without operative recovery to justify a careful analysis of the end-results to be expected. Despite all our newer means of diagnosis, this disease is still one primarily diagnosed either at operation or autopsy, and the suddenness with which the surgeon is confronted by the tumor mass demands some familiarity with the knowledge of operative risk, end-results and results to be expected by means of palliative operations and radical procedures. Because of the key situation very small tumors must early produce symptoms of blockage of the common duct, with or without blockage of the pancreatic passages as well. Because of this and because of the notoriously late metastasis, this tumor should be one most amenable to surgery, were it not for several complications. First of all, the operation, as has so many times been stated by other writers, must be done on a jaundiced patient. Thoroughly as this patient may be prepared by intravenous glucose, calcium or sera, the risk of hæmorrhage still remains second only to the risk of liver shock. Mortality of any operative procedure except an exploratory incision ranges from 30 per cent. to 70 per cent. depending on duration of jaundice and the type of operation performed.

Thus in the last few years, with all possible preparation, the following table represents the operative mortality reported in the literature. All cases are radical resections or stages thereof.

TABLE I

Author	Operative Death	Survived
Busch.....	0	1
Hingst.....	2	1
Bruning.....	2	1
Klinkert.....	0	1
Clar.....	0	1
Murgoci.....	2	0
Denks.....	4	1 (2 cases Sa
Van Remyne.....	0	1
Van Ardenne.....	0	1
Schofield.....	1	0
	11	8

Of these operative deaths, two had post-operative hæmorrhage, four had liver shock, three died of cardiac failure and one of general sepsis from

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cholangitis. Thus the gross mortality of cases reported within recent years is still 58 per cent. Of the fifty-nine cases reported before this time by Cohen and Colp, twenty-four died an operative death in the primary operation, both radical and palliative. In their own series of eight cases, six died an operative death, or a gross operative mortality, including their own report, of 45 per cent.

The end-results of any radical operation for carcinoma must receive a critical examination, especially in the face of a primary high mortality. This is self-evident, since there is fundamentally little value to any patient if the relief obtained by operation is neither complete nor lasting.

The number of patients dying within one year, from either rapid advance of the primary growth or of wide metastasis, seems to be relatively large when one considers that this tumor is supposedly slow in growth and late to metastasize. One must consider, however, that in the cases early reaching their termination, metastasis was occasionally present at operation, and certainly the average had a much longer history of complaints. After operation the patient is in every case relieved and usually permanently, of a most irritating and bothersome symptom—the itching of obstructive jaundice. A careful analysis of individual case reports in the literature demonstrates also the long intervals of freedom from pain or symptoms of any sort in successfully operated cases. Death usually comes about by more or less painless inanition, although pain can occasionally be a severe factor.

Aside from the palliation of symptoms, what chance does the patient have of actual cure, following radical operation? This is the question of most vital importance to any surgeon confronted with carcinoma in any region. Many authors have reviewed the literature in the past, the most complete reviews being found in the reports of Cohen and Colp, Fulde, and Hingst. Busch in 1928 made a complete analysis, reporting nine cases which lived one year or more. To this we have added more recent reports as follows:

TABLE II

	No. of years	Reported by
Körte.....	22	Busch
Lewis (Kelly).....	9	Lewis
Oehler.....	6	Busch
Van Remyse.....	6	Klinkert
Van Ardenne.....	5	Klinkert
Hingst.....	5	Hingst
Clar.....	5	Clar
Oliani.....	4	Cohen and Colp
Tenani.....	3	Tenani
Morin.....	2½	Busch
Novarro.....	2	Busch
Abell.....	2	Busch
Fulde.....	2	Fulde
Busch.....	1	Busch
Homans.....	1	Homans
Propping.....	1	Busch

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Thus there are a total of sixteen cases of eighty-one cases reported who lived more than one year, about two-thirds of which were still living and well when reported. The procedures in cases living four years or more were as follows:

TABLE III

Author	Procedure	Lived	Status
Körte.....	Transduod. Excis. Reimplant. C.D.	22	Symptom-free
Lewis.....	Transduod. Excis. Reimplant. C.D.	9	Symptom-free
Oehler.....	Transduod. Excis. Reimplant. C.D.	6	Symptom-free
Van Remyse.....	Transduod. Excis. Reimplant. C.D.	6	Unknown
Van Ardenne.....	Transduod. Excis. Reimplant. C.D.	5	Unknown
Hingst.....	Cholecystoduodenostomy	5	Died
Clar.....	Transduod. Excis. Reimplant. C.D.	5	Died
Oliani.....	Transduod. Excis. Reimplant. C.D.	4	Symptom-free

It is of interest that the case of Hingst, in which the tumor was not removed, still had a post-operative life of five years with a palliative operation. One can readily see, however, that the radical operation has brought the best and most lasting results. The case of Körte, wherein complete cure has seemingly occurred, is a very encouraging example. Schofield has recently advocated implantation of radon to the carcinoma, doing the palliative cholecyst-enterostomy and implantation at one operation. This method may, in the future, supplant radical excision, but judging from the above table, one must acknowledge the fact that excision gives the best hope of five-year cure. With this analysis, moreover, we cannot help but feel that the operation of radical excision is certainly justifiable when compared to the possible six months of life to be obtained by the average palliative measures.

Methods and technic of operation were fully discussed by Cohen and Colp in 1927, and further literature has given us few improvements from this standpoint except as to preparation of the patients. Employment of calcium or sera to control abnormal bleeding and coagulation time so often occurring in these cases has been of some value. The intravenous use of glucose to prevent post-operative liver shock and liver shock due to sudden decompression of the biliary system has also done much to decrease the operative risk in jaundiced patients. The lesson to be gained from the literature seems to be the value of further palliative procedure, such as cholecystogastrostomy and gastro-enterostomy when symptoms develop after the radical operation. It seems logical that cholecystogastrostomy combined with gastro-enterostomy, should, by widely diverting both bile and food from the site of possible recurrence, be the palliative measures of choice even to prophylaxis when earliest symptoms of recurrence present themselves.

To the above list of five-year cures we have the privilege of adding another. This patient was reported before the American Surgical Society in 1925 as a one-year cure. The clinical record in brief is as follows:

F. M., age fifty-two, admitted to the medical division May 6, 1924, complaining of itching, jaundice and weakness, of four months' duration. His stools were light yellow

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in color and he suffered with occasional indigestion. He was studied the usual time in the medical ward, and the following findings were reported: A palpable gall-bladder and enlarged liver. A Van den Bergh test slightly delayed direct, with indirect of 2.45 units. This was repeated five days later and the direct responded promptly, the faeces showing some bile pigment in the meantime. The phenoltetrachlorophthalein liver function test showed severe damage in that 20 per cent. of the dye was still present at the end of one hour. The Wassermann reaction was negative. Bleeding time was three minutes and coagulation time eight minutes.

He was transferred to the B. Service of the Surgical Department May 19, 1924, the Van den Bergh reaction having reached 5 units in the meantime. He was operated upon on May 20, 1924, with the provisional diagnosis of carcinoma of the head of the pancreas or common duct stone. At operation, a carcinoma of the ampulla of Vater about 1 inch in diameter was found by duodenotomy after opening of the common duct failed to reveal stones. This growth was removed in entirety by the cautery, and in order to avoid stricture by occlusion, a rubber tube was sutured in the common duct

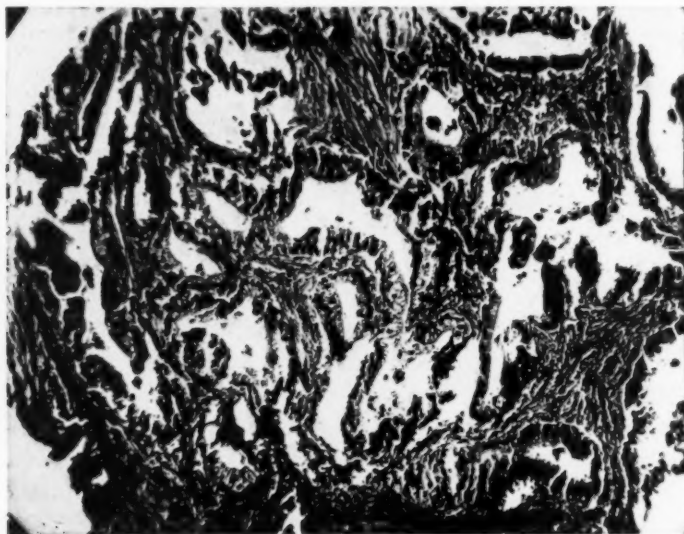


FIG. 1.—Periampullar carcinoma.

and allowed to hang 3 inches in the duodenum. Following this procedure convalescence was uneventful except for breaking down of the wound necessitating resuture eight days after operation. An X-ray taken on day of discharge revealed the rubber tube still in place. Sections of the tumor showed typical cylindrical cell adenocarcinoma (Fig. 1).

The patient returned seven months later, symptom-free. X-ray examination showed no rubber tube present and the Van den Bergh reaction had been reduced to 1.4 units. One year later his Van den Bergh test had become normal; 0.5 unit and 0.2 unit when presented before the American Surgical Association, March 2, 1926.

In June of 1926, or more than two years after operation, he returned, complaining of indigestion, itching, with occasional jaundice and vomiting accompanied by chills and fever. He had lost 16 pounds in weight in the previous three months, but was able to continue with his work. A gastro-intestinal X-ray done at this time shows a compressed, elongated duodenal cap, probably from external pressure. Three weeks later his symptoms had cleared up considerably and his Van den Bergh was again recorded as 0.2 unit.

He was readmitted August 12, 1926, complaining of pain, chills, fever and severe

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itching. He had clay-colored stools frequently but not continually, with bile in the urine. The Van den Bergh now was 3.5 units with an icteric index of 80. A cholecystoduodenostomy was done on August 17, 1926, from which he had a normal recovery with disappearance of all symptoms. At this operation the pancreas was found rather firm, but there were no definite signs of recurrence. A slight hernia developed in this wound, but he had remained perfectly well until January, 1927, when he commenced to suffer with pain and heaviness in the upper abdomen, gaseous eructation and nausea. These symptoms increased until he was readmitted on March 11, 1927, having suffered for ten days with severe, abdominal, cramp-like pains with vomiting. He had lost 18 pounds in the previous three months. A posterior gastro-enterostomy was done. The duodenum was found to be dilated but exploration was unsatisfactory because of the extensive and dense adhesions. No evidence of metastasis was present on superficial examination.

Following this operation, after a normal convalescence, the patient gained weight and for three months was entirely symptom-free. He then began to suffer with short attacks of epigastric pain, not related to meals. His stools were occasionally darkly colored. He was readmitted January 20, 1928, to the medical division, where studies revealed: Van den Bergh, delayed direct, indirect 1.4 units. Chest X-ray was negative for metastasis. The gastric analysis showed no free acid and the blood urea nitrogen was up to 34 milligrams per 100 cubic centimetres. A gastro-intestinal X-ray at this time showed a normally functioning gastro-enterostomy. The pylorus and duodenum did not fill and were therefore not observable. After being eight days on the medical service he was discharged, having improved greatly since admission; a slight tenderness being the only sign or symptom remaining.

Two months later he was readmitted to the surgical service, complaining of the same dull gnawing pain in the epigastrium, now coming on half an hour after eating and wearing away in the course of two hours. He could obtain no relief by diet or by alkalis, and an X-ray examination was therefore made at once. Melæna was now occasionally present, but bright red blood was never found in the stools. The gastro-intestinal X-ray made at this time showed a large duodenal cap and a well functioning gastro-enterostomy. Blood urea nitrogen was normal, 16 milligrams per 100 cubic centimetres, and the Van den Bergh showed 0.2 units. There was now a definite mass in the upper left epigastrium. This mass was tender and the size of an orange. The patient was given a treatment of intravenous lead, which was followed by deep X-ray therapy.

On the eleventh of September, 1928, he was readmitted, this time to the Neuro-surgical Service of Dr. Charles Frazier with the thought that chordotomy might give him relief of pain. At this time he was suffering extreme pain which doubled him up every attack, lasting two hours. Nothing relieved it except narcotics, which served to deaden it momentarily.

Physical examination revealed multiple masses of various size easily palpated through thin and emaciated abdominal walls. These masses varied in consistency, some being soft and others hard, filling the entire upper abdomen. Peristalsis was vigorous, painful and visible. The patient was very weak, his blood had become anæmic; hæmoglobin 40 per cent., red blood cells 3,500,000; but his Van den Bergh was still normal, 0.2 unit. Gastro-intestinal X-ray now showed a large pressure defect on the stomach due to the intestinal mass adjacent. It was obvious that the carcinoma was now rapidly spreading and metastasizing. Following several days' observation it was felt that chordotomy would not be advisable and the patient was discharged with narcotics to control his pain. He died January 27, 1929, or four years and eight months after operation. Post-mortem examination was not granted, but a communication from the family doctor revealed that œdema of the lungs, perhaps due to pulmonary metastasis, was a contributory cause of death. Thus, despite the need of three operative procedures, the patient lived some four years with comparative comfort, being able to

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keep at his work all this time, and pain was acute only during the last four months of his life.

Following this case step by step through his post-operative life, one cannot help but feel that the radical operation for this disease is much to be justified, especially when aided by later palliative measures, and the case has been reviewed in detail for this purpose.

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TORSION OF THE GREAT OMENTUM*

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TORSION of the great omentum was first referred to in the literature by Pierre de Marchettis in 1851. We owe the first full description of the clinical picture and operative findings to Oberst who published an account of torsion of the omentum caused by an adhesive band to the right inguinal canal, in 1882. A similar case was reported by Bayer in 1898. The next account in the literature was by Hochenegg in 1900 whose report and treatise were very full.

Up to the present time there have been reported twenty-two cases of so-called "idiopathic" omental torsion, and 147 associated with inguinal hernia. This meagreness of reported cases is by no means indicative of the frequency of its occurrence. It is probable that many surgeons have encountered this pathology without reporting it. I am not discussing this subject because of the rarity of its occurrence but to urge its consideration in the differential diagnosis of the acute abdomen; especially in the male with pre-existing inguinal hernia and a leucocyte count too low for the clinical picture of acute appendicitis.

In the acute surgical abdomen a positive diagnosis is oftentimes admitted to be difficult and the list of possibilities is a long one. The differential diagnosis of Henock's purpura and intussusception, acute pancreatitis and enterospasm or organic intestinal obstruction, appendicitis and tuberculous peritonitis have only to be mentioned as examples of pitfalls into which the surgeon may stumble in his attempt to make an accurate pre-operative diagnosis.

Many acute surgical conditions of the abdomen present the same symptoms and signs in their earliest stages and this fact increases the difficulty of an accurate diagnosis.

Torsion of the omentum is not to be found mentioned in surgical text-books under the differential diagnosis of acute appendicitis or acute cholecystitis and few text-books mention it at all. Keen's *System of Surgery* mentions it. Thomson and Miles, sixth edition, gives a complete but short description of the disease.

Torsion of the omentum has usually been diagnosed acute cholecystitis or acute appendicitis. A pre-operative diagnosis of acute epiploitis may have been guessed but it has never been made with any degree of certainty, according to the literature.

Let us briefly consider the comparison of the clinical pictures of acute

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epiploitis due to torsion and acute appendicitis. Age is not a factor. Omental torsion has occurred between the ages of fourteen and sixty-three years.

<i>Omental Torsion</i>		<i>Acute Appendicitis</i>
Sex	Predominately male	Not so predominately male
Early pain	Right iliac fossa 88 per cent.	Mid-abdominal more often
Vomiting	Infrequent	Common
Nausea	Infrequent	Frequent
Pulse	80-100	Rapid rising
Temperature ..	98°-100° F.	99°-102° F.
Rigidity	Less marked	Early
Tumor	Sudden and large	Slow development
Percussion	Dull	Resonant at first

The clinical picture presented by a patient suffering from an omental torsion will lead the experienced surgeon to operate at once, and this is only one of the many examples of how our treatment of acute abdominal disease has advanced beyond our powers of diagnosis.

Upon opening the abdomen in most of these cases previously reported, it was invariably noticed that the parietal peritoneum was cedematous and that upon opening the peritoneum there was a gush of sero-sanguinous fluid. This finding would be of some value to the operator where the incision was a McBurney, although we must remember that torsion of other viscera may cause sero-sanguinous peritoneal fluid.

The histology of the affected omentum in these cases reveals a venous thrombosis and a perivascular infiltration of mononuclear leucocytes, lymphocytes, and an occasional polymorphonuclear leucocyte. In no case have bacteria been found.

Omental torsion has been grouped under three distinct classes. The first class is the abdominal type where no hernia exists and there is no apparent cause for the torsion. The second class is the hernial type where a piece of twisted omentum lies in the hernial sac above, is associated with other viscera, or where the omental tip is connected to the inguinal canal by an adhesive band. The third class is that type secondary to other intra-abdominal pathology, most often appendicitis, where the right lower portion of the omentum is not in contact with the diseased appendix yet it is torted on its pedicle and is gangrenous.

Cases have been reported in which a portion of the omentum was twisted on a pedicle from one to nine turns, also cases in which the entire great omentum was torted on a pedicle.

There are many theories advanced as to the etiology of torsion of the omentum. The most plausible of these theories are:

1. Adhesions of the tip of the omentum causing the omentum to swing and twist a pedicle for itself as would a triangularly folded handkerchief when held between two hands and swung.

2. Exaggeration of normal movements such as a sudden strain, twist of the body or a jump. This theory is the most plausible one because in

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most reported cases there is neither a contributing anatomic cause nor a history of trauma, while in a few reported cases, and one of my own, a history of sudden straining and twisting of the body was followed by pain.

3. Increased intestinal peristalsis is thought by some to cause omental twisting.

4. Some believe the anatomical arrangement of the blood vessels predisposes to torsion.

5. Others believe that a previous inflammatory process leaving a localized area of omental thickening is the cause of the twisting. The explanation being that the thickened portion would be more cumbersome in its movements than would be the normal portions.

These explanations are all, however, only theoretical. The accurate answer as to the true etiology may be either one, a combination, or something entirely different.

There is not a single case on record of omental torsion due to an adhesive band in a femoral hernial sac.

The operative mortality on all reported cases since 1882 has been about 5 per cent. Of these seven deaths five were due to post-operative pneumonia and two were due to peritonitis.

In conclusion let me repeat that omental torsion is not a rarity among intra-abdominal lesions. It has probably been encountered a number of times by most surgeons and the surgical treatment is very satisfactory. It would be diagnosed more frequently if considered in the differentiation of acute abdominal conditions.

Four cases of omental torsion are herewith reported. Two of these cases belong to the abdominal or so-called idiopathic type, of which one was operated upon the clinical diagnosis of acute cholecystitis and the other for acute appendicitis. Of the other two cases, one belongs to the type associated with inguinal hernia while the last one belongs to the type associated with other intra-abdominal pathology, in this case an acute appendicitis. Each of these four cases is a typical representative of its type.

CASE I.—C. C., male, aged forty-seven, was admitted to the Lankenau Hospital. His chief complaint was abdominal pain of forty-eight hours' duration. Prior to the onset of the pain, which was gradual, he had been perfectly well. There had been no vomiting. He was sent to the hospital with the diagnosis of acute appendicitis. On admission the temperature, pulse, and respirations were 98.6° F., 80 and 20 respectively. The abdomen was moderately distended and there was some rigidity of the lower right rectus. The pain was exaggerated upon coughing and on deep inspiration. The blood count showed a leucocytosis of 11,600 with a normal differential count. The diagnosis of acute appendicitis made by the referring physicians was concurred in.

At operation a segment of omentum practically gangrenous was located just to the right of the umbilicus; the mass was twisted three times upon itself and adherent to the anterior parietal peritoneum. The affected portion of the omentum was excised. A normal appendix was removed coincidentally. The abdomen was closed without

drainage and the patient was discharged on the tenth post-operative day after an uneventful convalescence.

CASE II.—F. S., male, aged thirty-three was admitted to the Lankenau Hospital. His chief complaint was pain in the right upper abdomen of two days' duration. The pain appeared suddenly and did not radiate. There was slight abatement after belching large amounts of gas but the pain returned more severely than previously. His physician sent him into the hospital diagnosed acute cholecystitis. On admission the temperature, pulse, and respiration were 98.2° F., 102, and 18 respectively. He was obese. The abdomen revealed marked tenderness over the gall-bladder area and pain occurred there upon pressing any part of the abdomen. No tenderness over McBurney's point. The blood count showed a white cell count of 7,600 with 75 per cent. polymorphonuclears. The icteric index was 6 while the van den Bergh was normal. The diagnosis of acute cholecystitis was concurred in. At operation a piece of slaty blue gangrenous omentum about the size of a silver dollar was found twisted twice on its pedicle just below the hepatic flexure of the colon. Gall-bladder and appendix were normal. The affected piece of omentum was excised. Abdomen closed without drainage and the patient discharged on the twelfth post-operative day after a normal convalescence.

CASE III.—C. D., male, age thirty-seven, was admitted to the Lankenau Hospital. His chief complaint was lower right abdominal pain of seven days' duration. The pain was diffuse at first and the onset was gradual. No nausea or vomiting. Has had a right inguinal hernia for eighteen years and a truss would not retain the rupture. His family physician was called in, diagnosed acute appendicitis, and ordered him to the hospital at once. On admission the temperature, pulse, and respiration were 100° F., 104, and 24 respectively. The abdomen was obese and full. Peristalsis was tinkling in character. In the right lower quadrant a very tender mass could be palpated. There was moderate lower right rectus rigidity. A hernial sac could be palpated on the right side as the patient coughed. There was a leucocytosis of 11,900 with a normal differential. The pre-operative diagnosis in this case was appendiceal abscess and right inguinal hernia.

At operation the right lower tip of the omentum was hæmorrhagic and gangrenous, forming the mass in the right lower abdomen. The distal tip of omentum was twisted into a narrow strand extending down into the right hernial sac. The omentum was excised well above the affected area. A normal appendix was removed coincidentally. The abdomen was closed to a cigarette drain in the pelvis. Drainage was out on the seventh day and the patient discharged on the eleventh day.

CASE IV.—H. T., male, age twenty-three, admitted to the Lankenau Hospital. His chief complaint was right lower abdominal pain of two days' duration and of gradual onset. He was somewhat nauseated but did not vomit. His physician was called in, diagnosed acute appendicitis and sent him to the hospital at once. On admission the temperature, pulse, and respiration were 98.4° F., 120, and 24 respectively. The examination of the abdomen revealed pain, tenderness, and rigidity in the right lower quadrant. No herniæ. The blood count showed a leucocytosis of 16,200 with 67 per cent. polymorphonuclears, 25 per cent. lymphocytes, and 8 large monocytes. The referring physician's diagnosis of acute appendicitis was concurred in.

At operation a very mildly inflamed subcæcal appendix was removed. A piece of strangulated, gangrenous omentum, twisted on its pedicle twice, was removed. This affected omentum was about four inches away from the appendix. The abdominal wall was closed without drainage and the patient was discharged in nine days.

In each of these cases upon opening the peritoneum, sero-sanguinous peritoneal fluid was encountered and in the last three cases there was localized cedema of the parietal peritoneum.

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CARBUNCLE OF THE KIDNEY*

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CARBUNCLE of the kidney constitutes a rare but definite lesion. Macroscopically, it closely resembles the similarly designated infection so commonly encountered in the cutaneous and subcutaneous tela of the body. The condition was first described by Israel in 1891. This clinical entity offers a good prognosis, if the diagnosis is made early and the operation timely, for the infection in its initial stage consists of a circumscribed zone of multiple suppurative foci.

A review of the literature disclosed a total of 58 available cases: J. Israel¹, 1; Federoff, 1; Stucky, 1; W. Israel, 2; V. Herezel, 2; Ekehorn, 1; Kretschmer², 2; Barth, 4; Aschner³, 4; Mathe, 1; Rescke⁴, 4; McWilliams, 1; Horn, 1; Colmers, 2; Furniss, 1; Fischer, 1; Eisendrath, 1; Zinn, 1; Rjasanzewa, 2; Smirnow⁵, 5; Klumow⁶, 1; Voss, 2; Meso, 1; Rothbart, 1; Lipshutz, 2; Shapiro⁷, 1; Thompson⁸, 1; Dick⁹, 3; Kohler, 3; Moore, 2; Lazarus, 2.

It is very probable that the chronic carbuncle is more common than is generally believed.

CASE I.—J. P. (No. 46355), male, married, aged thirty-four. Referred by Dr. A. I. Rubenstone. Admitted to Mt. Sinai Hospital, November 18, 1927. The patient noted that he had been below par in his general health for three months prior to his admission to the hospital. He began to complain of a dull, aching pain over the right loin on September 31, 1927. The pain did not radiate, although one attack of pain was apparently colicky in character. No spontaneous pain was present when he entered the hospital. Urinary symptoms were absent.

The patient was a rather poorly nourished, somewhat anæmic male adult. The heart and pulmonary system were negative. Nose and throat examination disclosed an acute sinusitis, diseased tonsils and deflected septum. The physical examination was essentially negative, with the exception of a slight increase in muscle resistance and moderate tenderness over the right loin.

Blood Examination.—On admission—11,000 leucocytes; 81 per cent polynuclears; hæmoglobin-60 per cent.; 4,000,000 red blood cells. Within a week of his entrance to the hospital, his total leucocyte count began to mount, varying from 18 to 23,000 white cells associated with an increase in polynuclears (85 to 93 per cent.). The increase in the leucocytosis and in the polynuclears was apparently the result of an invasion of the infection into the loose pararenal tissues. Additionally, there was a progressive secondary anæmia. Three weeks after admission his blood count was 55 per cent. hæmoglobin and 3,000,000 red blood cells. The urine was frequently totally negative, but at intervals a few leucocytes and a trace of albumin were noted.

Blood cultures repeatedly negative. Smears and cultures from the urine negative. Wassermann negative. X-ray of the kidneys negative for stone. X-ray of the chest was negative. Fluoroscopy, however, showed a slight diminution in the movements of the medial segment of the right half of the diaphragm during respiration.

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The temperature ranged from 99.5 to 103° F. At cystoscopy:—the bladder and ureteral orifices were normal and catheters passed readily up both ureters. Following the intravenous injection of 10 cubic centimetre of 0.5 per cent. indigocarmine, the latter appeared at the left ureteral orifice in 3½ minutes; its appearance at the right orifice was delayed for 30 minutes, indicating considerable dysfunction of the right kidney.

All of the positive clinical findings pointed to an infection of the right kidney, with a possible involvement of the pararenal tissues. A transfusion of 500 cubic centimetres was given to the patient in preparation for operation.

Operation.—Right lumbar nephrectomy (nitrous oxide and oxygen anaesthesia). The kidney was bound down by massive adhesions, the result of a perinephritis and the fibrous transformation of the perinephric fat. The upper half of the kidney was the site of a large carbuncle which had perforated into the perinephric space, producing additionally a perinephric abscess. The kidney, its thickened capsule, and fibrous perinephric fat were completely extirpated.

Specimen.—Right kidney. The kidney is larger than normal. The capsule was greatly thickened, measuring, in some places, 3 millimetres and was inseparably fused to the fibrous pararenal fat. The upper half of the kidney showed a distinct mass which was bulging, and numerous small areas yellow in color, which exuded a greenish-yellow pus. The cut surface of the kidney presented a speckled appearance and numerous petechiae. Surrounding the large suppurating focus was a number of small nodes, the size of millet seeds, of the same character, but not directly connected with the large suppurative focus. The rest of the kidney exhibited evidence of a diffuse hyperaemia and cloudy swelling.

Microscopic.—The interstitial tissue between the tubules is densely infiltrated with polymuclear leucocytes. In some places the exudate has completely replaced the structure of the kidney. The glomeruli are not affected. The blood vessels are filled with thrombi. There is much fibrous tissue indicating the chronicity of the pathology.

Diagnosis.—Carbuncle of the kidney.

Pus from Kidney.—No tubercle bacillus found. Many gram-positive cocci. Culture showed staphylococcus aureus as did the guinea-pig inoculation.

Convalescence.—Convalescence was rather tardy, but marked by steady improvement. Discharged January 31, 1928. He has now completely recovered his health, assumed his normal activities, and has taken on 35 pounds in weight. Urine is now negative.

Comments.—The individuals affected are usually between the ages of twenty-two and fifty-five, although Barth¹⁰ and Colmer each report one in a girl of ten, and Smirnow one in a girl aged fourteen. The primary focus in most of the cases is some staphylococcic infection of the skin, most commonly a carbuncle or hard furuncle. Such infections are panaritium, mastitis, osteomyelitis of the finger, angina, and in three of Smirnow's cases, influenza, have been tagged as the primary focus. It is a matter of common knowledge that patients with boils, carbuncles, and acute osteomyelitis, occasionally develop metastatic renal and pararenal infections with the staphylococcus, which is the causative agent of the primary infection. Cabot¹¹ has recently directed attention to the association of upper respiratory infections and infections of the kidney. The interval between the healing of the primary skin infection and the appearance of clinical evidence of a renal or pararenal infection, is variable, ranging from two weeks to seven months with an average interim of three to five weeks. In one of the included case reports,

three weeks intervened between the healing of a small furuncle of the buttock, which was self-treated and the development of clinical signs of a renal infection. In a number of the reported cases, trauma was noted as a definite cause. In some of the cases no primary focus could be elicited or demonstrated. Chiralla,¹³ in a study of perinephric abscesses, noted that in two-thirds of the cases etiologic factors could not be found. It is probable, however, that the portal of entry of the infection was so trivial as to be overlooked or forgotten.

Pathology.—The infection begins in the interstitial portion of the cortex of the kidney and is practically always of hæmatogenous origin. Stoerck includes this type of infection under the general heading of "embolic suppurative nephritis."

From a pathologic viewpoint the first change produced in the kidney by the infected emboli is an infarct, which is soon converted into a suppurative focus. The base of this pyramidal-shaped infarct is always directed toward the cortex of the kidney, and the apex toward the pelvis. If only the small vessels are blocked, a renal abscess results; if many small vessels are occluded, multiple abscesses form and the entire viscus may be so affected. If the bacteria reaches the glomerular vessels, microscopic abscesses about glomeruli are produced (nephritis apostematosa). When a large vessel is blocked, either by bacteria or infected emboli, a renal carbuncle results. The apex of the pyramidal-shaped infarct is the site of the blocked vessel, and base of the pyramid is always directed toward the cortex. The destructive type, designated as renal carbuncle, is of rare occurrence as compared in frequency to the other types of renal abscess. In its original stage the infection is limited to the cortex, and in the overwhelming majority of cases, it is produced by one of the pus-producing cocci; staphylococcus aureus, and staphylococcus albus will be found in large numbers. The experimental production of infections of the urinary tract by intravenous injections of bacteria in the absence of obstruction to the urinary tract, gives a low percentage of positive results. The staphylococcus tends particularly to cause embolism of the vessels supplying the cortex, while the colon bacillus affects the vessels supplying the papillæ. It is difficult to explain why, in coliform lesions, the vessels of the papillæ are more liable to embolism than those supplying the cortex.

Considering the type of circulation of the kidney the latter must often be the site of both pyemic localization and innocent emboli. The infection, in a mild form, is probably more common than we believe, most of the cases terminating in spontaneous recovery. Cabot¹² in his comments on the cortical type of renal infection states: "My own experience has led me to believe that this type of coccus infection constituted a large majority of the cases, and that the opinion held some years, that in most of these cases severe destruction of the kidney occurred, which was likely to require operation, is probably wrong. With enlarging experience, I have found that the acute destructive type seems to constitute only a minority of the cases, and I believe that these lesions

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when not too extensive, show a tendency to spontaneous recovery. In the kidneys here examined, the attempt at spontaneous recovery is clearly evident from the presence of large amounts of fibrous tissue." Essentially, the microscopic image is one of extensive perivascular infiltration, thrombotic vessels and the presence of a large amount of fibrous tissue. The kidney in the advanced destructive stage presents a speckled appearance, the result of the conglomeration of variously sized, small abscesses filled with thick pus, the individual abscesses being separated one from another by densely infiltrated renal parenchyma. The division between the carbuncle and the rest of the kidney is more or less sharply demarcated. In most of the cases the development of epi- para- or perinephritis is the immediate cause for the development of severe symptoms.

Symptoms.—Since the infection is largely confined to the interstitial portion of the kidney, and usually does not involve the conducting system, these cases frequently present a puzzling clinical picture. Most commonly, it masquerades under the clinical syndrome of a perinephric abscess and rarely, as a subphrenic abscess. Instances where the renal carbuncle has perforated into the loose pararenal tissue, thus producing additionally a perinephric infection, are not infrequent. Cases of this type are reported by Smirnow, Barth, Voos, Zinn, Furniss, Fischer, Eisendrath¹⁴ and in the writer's case.

The symptoms are those of a mild or severe septicæmia with a swinging or continuous type of temperature elevation. Pains occur early and in the initial stage may be slight, and at times completely absent. Later in the disease, pain is constant, and varies in its intensity from a dull ache to a sharp localized pain.

More commonly the pain does not radiate, but in a number of the reported cases, the radiation of the pain to the abdomen was a prominent symptom. (Voos, Kretschmer, Mezo Bela, Smirnow.) The intimate anatomical relation of the ventral surface of the kidney to the peritoneum, duodenum, cæcum, colon, etc., readily accounts for the occurrence of abdominal pain, vomiting and meteorism in renal and pararenal infections. It is the anteriorly located cortical abscesses that are associated with symptoms that simulate appendicitis, cholecystitis and gastroenteritis. Such an abscess may perforate into the peritoneum and produce fatal peritonitis.

CASE II.—A massively obese female, aged thirty-six, was admitted to the hospital with a diagnosis of acute appendicitis. Temperature on admission was 100 degrees F., pulse rate 90, the leucocyte count was 19,000 with 88 per cent. of polynuclears. The previous history as far as could be obtained was negative. The examination of the urine showed only an occasional white cell, otherwise the findings were normal.

Careful physical examination disclosed marked tenderness over the right iliac fossa. The marked obesity rendered the examination for increased muscle tone or the presence or absence of the abdominal reflexes extremely unsatisfactory. No tenderness could be elicited over the loin, and in the angle between the twelfth rib and the erector spinæ mass. The clinical findings seemingly concurred with the diagnosis of acute appendicitis and the patient subjected to operation. The abdomen was opened through a right rectus incision. The peritoneal coat of intestines was injected,

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the abdominal cavity contained considerable seropurulent exudate. What seemed a moderately inflamed appendix was removed. Exploration of the other viscera in the abdominal cavity showed no additional pathology. The kidneys could not be palpated because of the large amount of adipose tissue.

On the third post-operative day the patient developed severe ileus and other evidence of peritonitis; she died within two days in spite of the usual post-operative measures. The autopsy revealed a large cortical abscess of the carbuncular type which had ruptured into the peritoneal cavity producing a fatal peritonitis.

This case clearly shows the difficulty of diagnosing this lesion and how closely the anteriorly located abscess may mimic an acute abdominal lesion. The presence of severe pain points to the sequential development of a perinephric abscess. Tenderness is most acute in the region between the twelfth rib and muscles of the loin. Frequently, however, the local signs are indefinite. In the included cases nothing more than mild, deep tenderness and a little rigidity of the overlying muscles were clinically evident. Cough, movement and deep breathing may aggravate the pain. Careful examination also reveals some restriction of the respiratory movements of the affected side. In a number of the reported cases an ill-defined, extremely tender swelling was felt in the loin, and in a few instances an actual bulge was visible.

Urinary symptoms are at times absent, but frequency and dysuria and particularly nocturia have been reported. Complete urologic study is required for the diagnosis in the doubtful case. In six of the twenty-one cases collected by Voos¹⁵ the urine is reported as normal. But a study of a centrifugalized specimen may show some red and white blood cells. In the fifteen remaining cases, some pathologic elements in the urine were found present. The most common urinary finding is a trace of albumin, a few red cells and some leucocytes. Study of the microscopic slides of the extirpated kidneys would seem to indicate that in very early stages of infection, the urine should exhibit a considerable number of leucocytes and bacteria, which later disappear, the result of the intensive fibrous tissue defense. In tracing the history of one of the included cases, the above statement is confirmed. In the advanced destructive stage, because of the large amount of fibrous tissue, the urinary findings are insignificant. An accurate estimation of pus in the urine by enumerating the formed elements of the blood (red blood corpuscles, leucocytes and casts) is best carried out in a counting chamber by a method similar in principle to that employed for blood counts.

Frankly, purulent urine clearly indicates that the infection has invaded the conduction system and was noted as present in only two of the collected cases (W. Israel and Mezo Bala).¹⁶ Bacteriologic study of the urine may reveal staphylococci.

Diagnosis.—The recognition of this malady in most of the reported cases was made only at operation. Yet a careful clinical survey and a complete urologic study should lead to the diagnosis.

Clinically, carbuncle of the kidney not infrequently pursues a chronic insidious course, and Beer²¹ very aptly labels this lesion with the caption, "silent infection of the kidney." The presence of a pyrexial illness, with or

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without rigors, pain, and tenderness over the loin, a persistent leucocytosis plus insignificant urinary findings, or even a normal urine, constitute the main signs and symptoms upon which the diagnosis is based. If, added to the latter, there is a history of a recent staphylococcic infection, or influenza and more or less impairment in the function of the infected kidney, the clinical picture is complete. Rothbart in one case established the diagnosis by means of the X-ray, noting the formation of an increasing shadow about the kidney upon repeated röntgenograms. Beer notes that in cases of cortical abscess in which the symptoms have subsided and diagnosis was difficult, activation of the focus by injecting staphylococcus aureus vaccine in a dose of from 100 million to 500 million, acts as a provocative test and accentuates the clinical manifestations.

Acute diffuse suppurative infection of the kidney may be impossible of differentiation from carbuncle of the kidney, the former, however, begins acutely and runs a more acute course.

The acute diffuse embolic type of renal infection has been well studied by George Emerson Brewer.²² Brewer's early interest in this subject was awakened by four or five examples of the severe or fulminating type of this disease, all of which proved fatal. Three autopsies demonstrated that the disease was unilateral and consisted of multiple embolic suppurative lesions, which in the observed cases, resulted in complete destruction of the kidney and an overwhelming and fatal toxæmia. As a result of this experience, a series of animal experiments were carried out. Sixteen animals were given an intravenous injection of pathogenic bacteria, and in addition to the inoculation, received an injury to one kidney. Five showed no lesion or only hyperæmia and parenchymatous degeneration. Two of the animals died within twenty-four hours of acute septic intoxication; of the remaining eleven, all developed surgical lesions of the kidney. The microscopy of the lesion was identical with that found in acute hæmatogenous renal infections, consisting of a plugging of the smaller arteries and capillary vessels with groups of organisms. Plugging of large vessels produced triangular septic infarcts. It was Brewer's opinion that the various types of renal hæmatogenous infections are but different stages of the same process. Brewer produced these lesions in animals by bacillus coli, streptococcus pyogenes, staphylococcus pyogenes aureus, bacillus typhosus and the pyocyaneus. The acute fulminating type of infection is well exemplified in the following case:

CASE III.—(No. 46793.) M. D., female, aged fifty-four, referred by Dr. Frank Leivy. Patient was admitted January 9, 1928, for the purpose of reducing her high blood pressure (220-210) which was of four years' duration. Incidentally, she complained of pain over the loin and painful urination. The patient, a rather obese female, complained of dyspnœa, severe substernal distress, and showed symptoms of cardiac decompensation.

X-ray of the lungs showed extensive peribronchial and alveolar infiltration with calcific deposits throughout. A large mass, four inches in diameter, was observed in the mediastinum involving chiefly the right side. The heart is displaced to the right, but appears normal. The right half of the diaphragm is smooth and rounder than

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normal, the dome of the left half is excessively high, being two and one-half inches above the right. The left diaphragm under the fluoroscope appeared definitely fixed. There was no evidence of pleurisy or effusion. The mass noted in the mediastinum was suggestive of a sarcoma. X-ray of the kidneys disclosed no abnormalities.

Blood count on admission was 8700 white blood cells. Repeated blood counts later showed a persistent leucocytosis, 17,000 to 29,000. Urine at all times showed pus, red blood cells but no casts. Blood chemistry 26 milligrams of urea, 115 milligrams blood sugar. Blood Wassermann was negative. Mosenthal test 11.19, NaCl 0.07 per cent. carbon dioxide 47 volume per cent. per 100 cubic centimetres of blood. Cultures from the kidneys disclosed bacillus coli with gram-negative and gram-positive bacilli. Blood cultures negative.

The urologic study showed bladder and ureteral orifices normal; indigo-carmin eliminated by both kidneys in nine minutes. Pyelograph disclosed a suspicious defect in the left kidney pelvis. A severe reaction followed the pyelography. Temperature rising to 103, pulse 110, associated with an increase in the severity of the pain over the left loin. The following day the patient had a chill lasting over five minutes, which was followed by unconsciousness for ten minutes. Pulse became thready and rapid, rising to 104. Blood pressure 160, heart action was very feeble. The patient continued to be stuporous, complaining of weakness and left lumbar pain. The case appeared as one of cardiac collapse with failure of renal function. Tenderness over the left renal region was marked. A catheterized specimen of urine now showed frank blood and many leucocytes. The pyrexial reaction was probably due to the lighting up of a latent infection in the left kidney. Cystoscopy was performed February 10, 1928. A No. 5 catheter was placed in the left ureter for drainage, from which catheter bloody urine appeared. The patient failed to improve, vomiting appeared and abdominal distention manifested itself. The catheter was removed at the end of two days, but the pain and tenderness over the left kidney persisted. Examination at this time showed increased resistance and tenderness over the left loin, the diaphragm moved freely. In view of the persistence of the pain and moderate tenderness over the left loin, an exploration of the kidney and perirenal space under local anaesthesia, was determined.

Operation February 15, 1928. Left lumbar nephrectomy (paravertebral and abdominal field block anaesthesia). The left kidney was found greatly enlarged, swollen and oedematous and was removed.

Convalescence from the operation was markedly smooth, showing a steady improvement in general symptoms, and a gradual and complete clearing up of the septic state.

The patient was discharged March 18, 1928, with the wound almost healed, her general condition much improved. The mass noted in the mediastinum was still present and showed no change in size. Her blood pressure is now 140 and shows no signs of elevation. The patient has resumed her household duties and is enjoying a fair state of health.

Pathologic Examination.—The kidney was considerably larger than normal, measuring 15 x 9½ centimetres and weighing 315 grams. The surface of the kidney was roughly granular, presenting numerous millet-sized seed nodes, many of which were aggregated in groups. Some of the nodes were dark red, others yellowish in color. The cut surface of the kidney was distinctly swollen and the cortex irregular. The pyramids were dark red and bulging. The mucosa of the pelvis and calices were hyperaemic and swollen. Many microscopic sections were made of every part of the kidney, disclosing a diffuse renal infection. Some portions near the cortex presented a complete loss of the normal renal picture—remnants of necrotic tubules and glomeruli, and a dense leucocytic infiltration. The kidney exhibited a massive and dense accumulation and diffusion of leucocytes, both polynuclears and lymphocytes. The tubules, with the exception of an occasional necrotic area, revealed only a high degree of cloudy swelling. The glomeruli were distinctly hyperaemic, and in certain areas a serous exudate filled the space of Bowman. The perivascular spaces between the

CARBUNCLE OF THE KIDNEY

glomeruli were particularly affected, the leucocytic infiltration spread radiating from the perivascular spaces. The picture is that of an acute diffuse suppurative nephritis. Some of the glomeruli are hyalinated and the walls of the blood vessels present evidence of arteriosclerosis.

Diagnosis.—Acute diffuse suppurative nephritis (early stage). Arteriosclerotic kidney (slight stage).

Bacteriologic Report.—Culture of kidney (post-operative). Direct smear: Many pus cells, gram-negative bacilli, few gram culture: *B. coli*.

Radiation of the pain to the abdomen and the presence of a mass in the right iliac fossa may lead to a diagnosis of appendiceal abscess. Such a case is reported by Meso.¹⁶

The patient, a girl, aged eighteen, was admitted to the hospital with a diagnosis of an appendiceal abscess. A mass the size of a fist occupied the right iliac fossa. Catheterization of the right ureter revealed pus. The left kidney was normal. Upon these findings a diagnosis of appendiceal abscess was made with a resulting secondary pyelitis. At operation the appendix was found to be normal, but exposure of the right kidney revealed that its lower half was the seat of a large carbuncle. Because of the long duration of the illness, and the poor condition of the patient, only incision and drainage were performed. Recovery ensued.

Treatment.—Excellent results follow nephrectomy, provided the other kidney is normal. Toxic nephritis in the other kidney does not contra-indicate operation. Colmer's analysis of sixteen cases shows that two died without operation, and four cases in which only a nephrotomy was done, also died. The infection in the kidney at the time of operation is usually so far advanced that only removal of the affected viscus offers a promise of cure. Only three of the collected cases showed an involvement of both kidneys (Kretschmer, Stucky and Rjasanzewa). Stucky's case is of particular interest for it is the only available recorded instance in which a carbuncle developed in both kidneys with the recovery of the patient. In the latter patient, five weeks after the removal of one kidney, which was the site of carbuncle, the other kidney revealed clinical signs of a carbuncle. The latter was drained and the patient subsequently discharged as cured. Incision and drainage leaves a large infected area and exposes the patient to a possible hazard of a difficult secondary nephrectomy. In a number of instances, as noted above, the primary operation consisted of incision and drainage of a perinephric abscess. Recovery did not take place and a subsequent operation disclosed a carbuncle of the kidney as the cause of a perinephric abscess necessitating a nephrectomy.

Kohler has successfully treated two cases of solitary carbuncle of the kidney with the following technic. The kidney is exposed by means of a lumbar incision, delivered into the wound and decapsulated. The exposed kidney is now punctured in some twenty places by means of a small cannula, both infected and uninfected portions of the viscus being punctured. The site of each puncture is injected with 2 per cent. Rivanol. Most of the injected antiseptic flows out through the puncture openings. The kidney is now replaced, the wound closed, a small gauze drain being introduced through the lower angle. It is well to recall that Brewer²² advised decapsulation of the

kidney as the treatment of choice in the intermediate type of acute haematogenous renal infections, a group which has been aptly termed the glaucomatous kidney.

When the case is subjected to operation, while the infection is limited to a small area of the cortex, resection of the infected kidney focus may be feasible. The latter procedure was successfully carried out four times. The conservative resection of the infected focus, in properly selected cases based upon the premises of the pathology of this lesion, is a sound and logical operation since the infection begins in the cortex and is rather sharply demarcated from the uninvolved part of the kidney.

The infarct in the early stage of the infection can easily be removed and the resultant cavity packed with gauze. The wound should be left open to prevent an extensive area of infection.

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TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD NOVEMBER 3, 1930

The Vice-president, Dr. JOHN SPEESE, in the chair
CALVIN M. SMYTH, JR., M.D., Recorder

PRIMARY GIANT-CELL TUMOR OF THE PATELLA

DR. LEONARD G. DOBSON (by invitation) reported the case of a man aged twenty-four who was admitted in the orthopædic service of Dr. A. B. Gill in the Hospital of the University of Pennsylvania January 28, 1930 complaining of pain and swelling of the right knee. A year previous to admission he had fallen, striking his acutely flexed right knee on the pavement. He felt something snap in his knee and had severe pain when moving his leg. The knee was strapped but had remained swollen and tender ever since. For several months previous to admission he had noticed that the right knee cap was getting larger, was hot to the touch and that motion of the leg, especially extension, was painful. When admitted the right patella was enlarged, smooth and the skin over the patella was red and hot to the touch. Pressure upon the patella was very painful. Repeated studies of the blood and urine were negative for pathology and the blood Wassermann was negative in all antigens. Old tuberculin intracutaneously was negative for reaction for .1 milligram in twenty-four and forty-eight hours.

A röntgenogram of the knees taken January 13 showed that there had been an old fracture through the right patella. In addition there is now considerable rarefaction and some tendency to trabeculation of the patella. This appearance is rather unusual for a simple fracture of the patella.

At operation January 30, by Dr. A. Bruce Gill, the vessels about the patella were found congested. The patellar ligament was elevated subperiosteally and there was free bleeding from the congested veins. The cortex of the patella was firm but when a small piece of the cortex was removed the patella was found to be a shell filled with blood and dark material which resembled degenerated blood clots. The soft, spongy material was carefully curetted out. The interior of the patella bled very freely and was packed with gauze to control the hæmorrhage; the anterior portion of the cortex was crushed in and the wound closed, leaving the end of the gauze packing extending out of the wound. A posterior plaster splint was applied.

Culture of the material removed from the patella revealed no growth except a few diphtheroids. Dr. Herbert Fox reported on the microscopic examination of the tissue as follows: "Within a mass of blood was found a piece of tissue showing giant-cell tumor of bone, suggestive of sarcoma be-

cause of the irregularity and indefiniteness of the blood spaces. Examination of the decalcified bone from the cortex shows some rarefaction, fibrillary bone formation and masses of pigment, but no tumor was found."

Following the operation the patient made an uneventful recovery. The gauze packing was removed on the second day after the operation. The posterior splint was left on for six weeks after operation, being removed for dressings. Examination March 12 showed the patient able to walk but there was still some tenderness over the patella. X-Ray examination at that time showed: "Marked improvement in the right patella since last examination as indicated by considerable new bone formation. There is still some rarefaction."

Follow-up on the patient ten months after operation found him com-

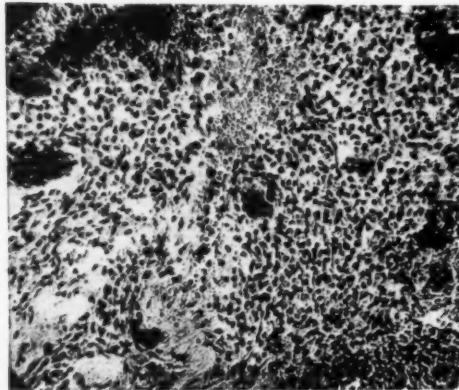


FIG. 1.—Low power photomicrograph of the tumor tissue (x 250) showing chronic inflammation, bone spicules and giant cells.

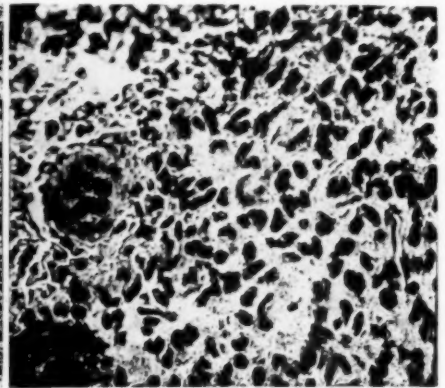


FIG. 2.—High-power photomicrograph (x 700) of the tumor tissue. Shows the very cellular cytoplasm.

pletely recovered and in excellent health. The right patella was no longer tender and was about the size of the left.

The reporter stated that tumors of the patella are very rare. Cole¹ in 1925 reported the first benign cyst of the patella. He surveyed the literature, both American and foreign, and found twenty-four other cases of primary tumor of the patella. These included all the common tumors of bone except myxoma. In these twenty-five cases were included three cases of giant-cell tumor of the patella. In 1924 Faltin² reported a case of giant-cell tumor of the patella which had not been included in the three reported by Cole. King and Towne³ in 1929 reported the fifth case of giant-cell tumor of the patella. The case being reported is therefore the sixth case of primary giant-cell tumor of the patella recorded in the literature.

Giant-cell tumor is the term now generally used to designate a specific tumor. The condition has variously been called giant-cell sarcoma, myeloid sarcoma, hæmorrhagic osseous dystrophy, myeloma, osteitis fibrosa with giant cells and chronic hæmorrhagic osteomyelitis.

Lebert⁴ is credited with first recognizing the condition in 1845. He noted

PRIMARY GIANT-CELL TUMOR OF THE PATELLA

the giant cells in certain medullary tumors but did not at first separate the benign giant-cell tumor from malignant sarcoma of bone. Robin,⁵ in 1850, described certain benign tumors of bone which contained many giant cells. Paget⁶ further described the condition in 1853. In 1860 Nélaton⁷ wrote a monograph on the subject describing the reddish, jelly-like appearance of the tumor tissue. He noted its capacity to absorb bone and widen the marrow cavity and fully established its benign course and the wisdom of conservative treatment. In 1879 Gross⁸ presented the results of the study of seventy cases of giant-cell tumor and also emphasized their benign nature.

Although many writers had emphasized the benign nature of giant-cell tumors most of the surgeons treated the condition as malignant and employed radical treatment until Bloodgood⁹ in 1910 again pointed out their benign nature. In 1920 Bloodgood⁹ reported forty-seven cases of giant-cell tumor in none of which had metastasis occurred. Codman¹¹ in 1925 reported that 100 cases of giant-cell tumor had been registered without a true case of metastasis. Stone and Ewing¹⁰ in 1922 held that rarely if ever does a true giant-cell tumor metastasize. Cole¹ in 1925 stated that giant-cell tumors are benign and could be cured by curettement followed by cauterization.

Authors do not share the opinion that all giant-cell tumors are benign. Coley¹² in 1924 presented an analysis of fifty cases of giant-cell tumor and found that metastasis had occurred in nine. In 1927¹³ he reported follow-ups on fifty cases, included nineteen new cases and reached the conclusion that, "It is not always possible to differentiate the malignant from the benign cases by the clinical Röntgen-ray and microscopic data. Giant-cell sarcoma, or 'giant-cell tumor' as it is designated by most pathologists today while in the great majority of cases, a benign or at least only locally malignant lesion, should still be classed as a sarcoma since in certain cases it has all the clinical features of a malignant bone tumor causing death by metastases."

Chatterton and Flagstad¹⁴ in 1927 reported two cases which had been diagnosed giant-cell tumor microscopically which developed malignant changes.

Single giant-cell tumors are not uncommon. The literature contains reports of several hundred cases. In 1927 Alexander and Crawford¹⁵ reported a case of multiple giant-cell tumors and included a summary of twenty-four such cases collected from American and foreign literature.

Giant-cell tumors most often appear at the ends of the long bones, where, according to Christensen,¹⁶ "there is an epiphyseal disc of maximal growth, where the growth period is longest and where the natural growth momentum is greatest." They also arise in the maxillæ (epulis type) and according to Ewing¹⁰ very similar tumors occur in the capsules of joints and along the tendon sheaths and bursæ.

In the long bones giant-cell tumors produce reddish, jelly-like masses resembling granulation tissue and replacing the cancellous portions of the bone. The tumor may expand the shaft of the bone with the periosteum laying down an advancing shell of new bone. The shell of bone may be

come so thin that it will crackle. The centre resembles splenic tissue except it has a firmer opaque cut surface and the central cystic areas are soft and infiltrated with blood. The outer bony shell may become thin and allow passage of the tumor tissue but there is seldom any tendency toward invasion of soft parts.

Giant-cell tumors are characterized by the abundance of large giant cells containing many small, separate oval nuclei. The tumors are believed to take origin from the fibrous tissue framework of bone, either from the periosteum or endosteum. The etiology of this type of tumor is obscure but it is quite well established that trauma is the most common cause of single lesions. The classification of giant-cell tumor is unsettled; some claiming it is inflammatory, others neoplastic, and still others that it is a mixture of the two. Alexander and Crawford¹⁵ state that, "It is generally considered as resulting from some chronic irritation, which may follow a metabolic disorder." They further account for the development of the condition as follows: "The inflammatory proliferation of tissue is then essentially a regenerative process which has for its aim the compensation of the lesion produced by the cause of inflammation. Under special conditions this leads to a hyperplastic proliferation of connective tissue, frustrates its own aim and causes new damage. This is particularly the case when, as a result of the inflammation in the organism, there is kept up a permanent condition of inflammation. The bone tissue thus replaced by cellular tissue softens and produces multiple bone cysts lined with fibrous tissue and filled with clear fluid, fibrocystic osteitis, or within the fibrous tissue lining the giant-cell tumor develops."

Giant-cell tumors grow slowly, do not metastasize, appear trabeculated by X-ray and do not produce cachexia. The tumors may be present an indefinite time without giving rise to symptoms and often the occurrence of pathologic fractures is the first indication of their presence.

Diagnosis is based on the history, usually that of trauma; on the characteristic trabeculations by X-ray; and biopsy with microscopic examination.

The treatment generally advocated in cases of giant-cell tumor consists in thorough curettage with or without the application of pure carbolic acid followed by alcohol or with 20 per cent. zinc chloride. If the cavity is large it may be Dakinized, but usually simple packing is adequate. X-ray gives excellent results and numerous cures have been reported. Herendeen¹⁷ in January, 1930, reported three cases of giant-cell tumor that had responded very well to X-ray therapy.

Regarding the rarity of tumors of the patella Christensen¹⁶ states: "The patella seems singularly immune to bone tumors in spite of the fact that it is probably subjected to a far greater amount of trauma than any other bone in the body. It seems reasonable to assume that the immunity to bone tumors which the patella enjoys is probably due to the absence or loss of growth restraint, incident to active diaphyseal growth and pressure epiphyses. The fact that the patella develops from an endochondral center, that it has

PHRENIC NERVE EXERESIS FOR LUNG ABSCESS

a relatively short period of growth, and that it is a sesamoid bone may be of importance."

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DR. A. BRUCE GILL remarked that out of twenty-seven cases reported in the literature this is only the sixth one of a primary growth in the patella. The report from the X-ray department suggested that it might be a giant-cell tumor, but the speaker could not entirely dismiss the thought that it might be a cyst and when he opened the cortex and found a very soft mass, which closely resembled an old blood clot, he thought he was dealing with a hæmorrhagic cyst; free bleeding also suggested that. The mass was so soft it was difficult to get out for microscopic examination.

PHRENIC NERVE EXERESIS FOR LUNG ABSCESS

DR. RICHARD H. OVERHOLT (by invitation) presented a man aged twenty-five, who was admitted in the medical service of the Hospital of the University of Pennsylvania September 14, 1928. He had had a tonsillectomy under general anaesthesia four weeks previously, which was followed in a week's time by pain in the chest, cough, foul expectoration and fever. He had lost sixteen pounds in weight. There were no other symptoms.

Physical examination revealed nothing remarkable except an area in the right chest in the posterior axillary line over which the breath sounds were harsh and occasional râles could be heard. There was a moderate secondary anæmia, the hæmoglobin being 62 per cent. The leucocyte count was 15,400. The Wassermann reaction was negative. Acid-fast organisms were not

present in the sputum. A röntgenogram of the chest revealed an abscess in the lower portion of the right upper lobe, centrally located. Bronchoscopic examination showed mucopurulent material coming from the right upper main bronchus. A smear and culture of this material showed a mixed group of streptococci, staphylococci and micrococcus catarrhalis but no fusiform organisms or spirilla were observed.

Six bronchoscopic treatments were given over a period of four weeks at the end of which time the lesion had progressed in size and had extended to the periphery of the lung (Fig. 3). External drainage was recommended and the patient was transferred October 12, 1930, to the surgical service of Dr. George P. Muller.

An exeresis of the right phrenic nerve was done and this followed in three days by a first-stage thoracotomy by Dr. Selling Brill. A portion of the

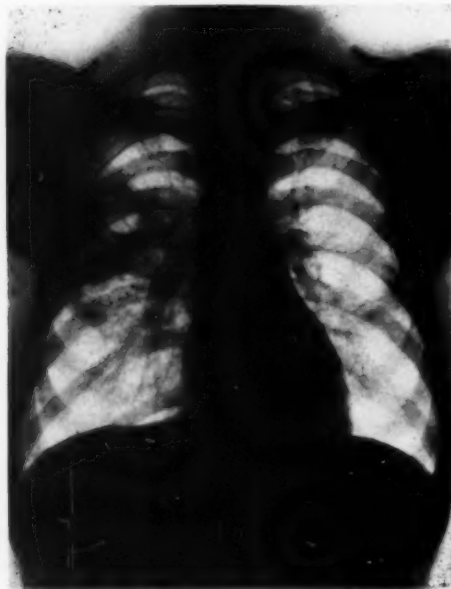


FIG. 3.—Case J. B. Röntgenogram made six weeks after onset of symptoms of lung abscess. Lesion in lower portion of right upper lobe. Note size of lesion and extension to the periphery.

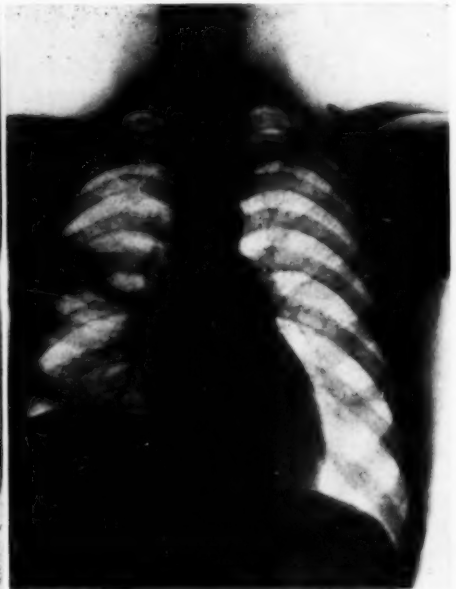


FIG. 4.—Case J. B. Röntgenogram made two weeks after right phrenic nerve evulsion and one week after first-stage thoracotomy. Three inches of the seventh and eighth ribs over the lesion had been removed and the wound packed with gauze. Note diminished size of right thorax due to elevated position of the diaphragm and almost complete disappearance of the lung abscess. Decision not to complete surgical drainage was made at this time.

eighth rib was excised in the posterior axillary line. In the course of the procedure the pleura was injured and an accidental pneumothorax resulted. The lung was immediately reexpanded by positive pressure anæsthesia and the rent in the pleura closed. A metal marker and gauze packing were placed in the wound. A subsequent röntgenogram showed the marker to be slightly below the abscess so that on October 20 (four days later) Doctor Muller enlarged the thoracotomy opening, resected the next rib above and repacked the wound. Immediately following these preliminary procedures, the patient's cough and expectoration subsided and the temperature dropped to normal. A röntgenogram of the chest October 27 (fourteen days after

ELECTROCAUTERIZATION IN TREATMENT OF HUMAN BITES

phrenic exeresis and seven days after first-stage thoracotomy) showed an almost complete disappearance of the pulmonary lesion (Fig. 4). Because of the clinical and röntgenological improvement, the second-stage operation was not carried out so that actual surgical drainage of the abscess was not done. The patient was discharged two weeks after the last operation with a healed thoracic wound.

The patient was seen in the follow-up clinic one month later. All symptoms and signs of a pulmonary abscess had disappeared. He had been able to resume his former work. A röntgenogram gave evidence of slight fibrosis at the site of the previous lesion. The diaphragm on the right side was elevated and restricted in its movement (Fig. 3). After two years the patient was reexamined. There had been no recurrence of the lesion and the röntgenogram showed a clear lung field on the right with a persisting diaphragmatic elevation.

The speaker remarked that the points of interest in this case are: (1) The rapid disappearance (two weeks' time) of a large pulmonary abscess during the course of surgical treatment without the necessity of actually draining the abscess; (2) the probable value of phrenic nerve interruption in the treatment of a thin-walled, easily collapsible, pulmonary abscess; and (3) the difficulty of evaluating the effect of the different surgical procedures in this case. The accidental pneumothorax was probably of little moment in that the lung was reexpanded at the time and a röntgenogram forty-eight hours after operation did not show air in the pleural cavity. The removal of two ribs over the site of the abscess may have released the parietal pleura sufficiently to aid in the collapse of the walls of the abscess cavity which was so close to the periphery. Undoubtedly, most of the diminution in thoracic volume which permitted the walls of the abscess to collapse and obliterate the cavity was due to diaphragmatic relaxation. Because of the rapid disappearance of the pulmonary lesion in this case, the question is raised as to whether permanent diaphragmatic paralysis was necessary. Temporary paralysis by only crushing the nerve might have been sufficient.

ELECTROCAUTERIZATION IN TREATMENT OF HUMAN BITES

DR. WILLIAM BATES read a paper with the above title, for which see page 641.

DR. HUBLEY R. OWEN said that in his work as a Police Surgeon he had had 200 cases of human bites in twenty-three years. In spite of the fact that he has tried every known treatment, he personally feels that he is not getting any better results now than twenty years ago. This same character of wound is received by more or less peaceful policemen making prisoners. Some years ago he reported two chancres developing from wounds of this character. He has not been able to get the same results as Doctor Bates with the cautery, but perhaps did not try it sufficiently. He has tried everything; one of the main things he has had to contend with is internes sewing these wounds up without drainage. He always opens the wounds widely under gas anaesthesia. Exposed metacarpo-phalangeal joints in these cases show rapid destruction

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of the cartilage, probably because the impact is one of the cartilage originally and because of the poor blood supply. Infection and ankylosis of the metacarpo-phalangeal joint often occur. One case required amputation. The speaker asked Doctor Bates how far he suggested going with the cautery when tendons were exposed. Doctor Owen is at present treating these cases by wide incision under general anaesthesia followed by continuous immersion in warm boric solution. He will be glad to try electrocauterization again.

DR. JOHN FLICK said that he had been trying to study cases of human bites bacteriologically but unless examination is made very promptly and very carefully the spirochetes are missed; they are difficult to culture and unless the material removed is examined within a half hour the organisms are not found.

DR. M. J. HARKINS remarked that Doctor Bates' success with cauterization might be due to the fact that the severe course of many cases of bites is due to invasion by anaërobic bacteria. Many antiseptics have little if any value in this type of infection and it may be that the severe disinfection of the cauterization is responsible for the cleansing effect.

DR. WILLIAM BATES said that after going over his findings and various reports in the literature about the types of infection, he decided to wait for a few more cases and have them cultured before treating them, but none of these showed the streptococcus fusiformis. Regarding depth of cauterization, he thought one would be justified in carrying it to the point of complete débridement, even though it was necessary to sacrifice a tendon.

COMPARATIVE STUDIES OF ANTISEPTICS IN EXPERIMENTALLY PRODUCED LOCAL INFECTIONS

DRS. ELI SALEEBY and M. J. HARKINS, by invitation, read a paper with the above title.

END-RESULTS IN RADICAL OPERATIONS FOR CARCINOMA OF THE PERIAMPULLAR REGION

DR. GEORGE P. MULLER, and, by invitation, DR. LEE RADEMAKER read a paper with the above title, for which see page 755.

STATED MEETING HELD DECEMBER 1, 1930

The President, DR. GEORGE P. MULLER, in the Chair

CALVIN M. SMYTH, JR., M.D., Recorder

PERFORATED DIVERTICULITIS OF THE SIGMOID

DR. S. DANA WEEDER reported the case of a man, age forty-one, who was admitted to Chestnut Hill Hospital in the service of Dr. William B. Swartley, November 30, 1929. His chief complaint was abdominal pain. Seven days prior to admission he was seized with a dull pain in the left lower abdomen following a meal. The pain was relieved by taking soda, but returned two days later and was not relieved by taking soda. The pain

PERFORATED DIVERTICULITIS OF THE SIGMOID

continued until the day before admission when it became much more severe. He had a daily bowel movement until two days before admission, since which time he had been constipated and vomited frequently. There was no blood noticed at any time in his stools and no history of previous attacks of similar pain or other symptoms referable to the colon.

When admitted there was some distention of the abdomen with tenderness and some rigidity over the left lower quadrant. No masses could be palpated. The peristalsis was greatly diminished. Rectal examination revealed a tender mass in the left side. The rest of the physical examination was essentially negative. The temperature was 99, pulse 100, respirations 20. The X-ray report on a barium enema was as follows: "There is a delay in filling, apparently due to spasm of the colon. Coils of ascending colon are bent on themselves whether or not due to adhesions is impossible to say." The blood count showed hæmoglobin of 75 per cent., red blood cells, 3,800,000, white blood cells 15,000.

At operation on December 1, on opening the peritoneum a brownish fluid escaped. Further exploration revealed brownish purulent material with a faecal odor in the neighborhood of the sigmoid. Thick creamy pus escaped from deep in the pelvis. There were two faecal concretions free in the peritoneal cavity beside a hole in the sigmoid large enough to admit the tip of the little finger. The mesentery of the sigmoid was greatly thickened, œdematous, covered with fibrin and in several places necrotic. The perforation was closed and three cigarette drains and a rubber tube inserted. The patient died three days later.

DOCTOR WEEDER reported a second case which also bears out the observation that diverticulitis occurs most commonly in middle-aged rather obese subjects, a man aged forty, admitted to the Germantown Hospital, November 29, 1928, in the service of Dr. Edward B. Hodge. His chief complaint was pain in the left lower abdomen. The pain began the day before admission to the hospital for which he took Epsom salts which purged him freely. There was no nausea or vomiting. For some years he had taken milk of magnesia for indigestion and constipation. The man did not look acutely ill. There was tenderness and slight rigidity in the left lower abdomen, the point of greatest tenderness being about an inch and a half from the umbilicus on a line drawn from the umbilicus to the anterior superior spine of the ilium. Rectal examination revealed a tender mass slightly to the left of the mid-line. The examination was otherwise negative except for a systolic murmur heard at the apex of the heart. The temperature was 99.6, pulse 100, respiration 24. The white blood cell count was 12,500; blood Wassermann, negative.

At operation November 29, a search was made for Meckel's diverticulum but none was found. The gall-bladder was normal; no masses were found in the liver; the stomach, duodenum and the appendix were normal. A mass, hard and indurated, was found in the pelvis which proved to be contained within the sigmoid. There was considerable œdema of the mesentery and epiploic appendages, several of which were attached by fibrinous exudate over the inner aspect of the sigmoid. By separating the peritoneum lateral to the sigmoid, with its mass, it was possible to deliver this loop of sigmoid through a second incision in the left lower quadrant, the Mikulicz procedure having been determined upon. A glass rod was run through the mesentery of the loop in order to hold it. The mid-line incision was then closed.

The second stage was done on December 6, the loop of sigmoid being removed by the cautery. Two days later a clamp was applied to obliterate

the spur. The clamp came off on the twelfth day. As there was not sufficient spur destroyed the clamp was reapplied and it finally cut through by the end of the fourth week and the final stage was done January 3, 1929.

On January 17, emphysema was noticed extending over the left lower abdomen and scrotum. There was an elevation of temperature to 101 and pulse to 100. However, the patient did not appear to be toxic. The wound was opened down to the aponverosis and a brownish foul-smelling, purulent material and gas were liberated. In twenty-four hours the emphysema had extended to the left ankle; but the temperature had subsided and the pulse fell to 80. By January 31 the emphysema had practically disappeared and the wound looked healthy. An anaërobic culture was made to determine the presence of Welch's bacillus which was not found. The culture showed bacillus coli communis, a member of the dysenterial group and bacillus pyocyaneus.

The pathological report on the section of sigmoid showed no evidence of new growth and the diagnosis was acute perforated diverticulitis. The patient was discharged February 2, 1929.

This patient, since his discharge from the hospital, has been in good health, has daily stools with the aid occasionally of mineral oil. There is a hernia at the site of the incision in the left lower abdomen.

The speaker remarked that since 1849 when diverticula of the colon were first described by Cruveillier many have written on the subject. Colonic diverticula are not uncommon. Inflammatory changes with subsequent complications occur in about 17 per cent. of the cases of diverticulosis observed clinically, and about 14 per cent. observed at necropsy. In a group of 227 cases malignancy was associated in only 1.8 per cent. However, it should be emphasized that the surgeon is frequently deceived at the time of operation as to the true nature of the lesion and that a certain diagnosis cannot be made until the specimen has been examined microscopically.

Doctor Weeder believes that there is a certain group of cases reported as five-year cures of carcinoma of the colon without microscopic verification that were actually diverticulitis.

DR. DAMON B. PFEIFFER recalled a patient in whom diverticulitis was discovered by X-ray, in which there were some pelvic symptoms, and the surgeon, in his exploration, finding nothing in the pelvic organs themselves to account for this, resected a large portion with a disastrous result. The sigmoid is not a very good place to resect on account of the blood supply. It is not necessary to operate always. Even when a mass presents itself if it can be controlled, it is part of wisdom in certain cases to let that mass subside. He has seen a very considerable mass, the size of a fist, practically disappear on treatment. Of course, in the case of perforation, there is no choice but to operate.

DR. GEORGE P. MULLER said that a sigmoid diverticulum may produce a rapidly acute peritonitis which may be mistaken easily for appendicitis. The speaker thought that most surgeons have the conception of diverticulitis as a condition producing a gradual obstruction of the sigmoid, thus resembling carcinoma or a perforating retroperitonitis and forming a suppurative mass

CARBUNCLE OF THE KIDNEY

in the groin. He had had three or four of the acute variety, all of which were diagnosed as pelvic appendix and in all a normal appendix was found, a greatly thickened cæcum felt, and thus the true nature of the infection discovered. In two of these patients, transitory fistulæ occurred. It is difficult to know what to do in these cases but probably the best treatment is simply to place good drainage.

TORSION OF THE GREAT OMENTUM

DR. JOHN JEFFRIES (by invitation) read a paper with the above title, for which see page 761.

DR. WILLIAM B. SWARTLEY recalled the case of a woman, over sixty years of age, who was received at the Chestnut Hill Hospital with the diagnosis of acute cholecystitis. At the operation the gall-bladder was not found to be the cause of the acute condition, although it did contain stones but a part of the omentum was found to be firmly adherent to the peritoneum covering the abdominal wall just below and lateral to the gall-bladder. This part of the omentum after it had been separated from the abdominal wall was found to be dark in color and to be the seat of three complete twists at the base of the darkened or gangrenous area. This piece of omentum was resected; the gall-stones were removed, the gall-bladder drained and the patient made an uneventful recovery.

CARBUNCLE OF THE KIDNEY

DR. BENJAMIN LIPSHUTZ read a paper with the above title, for which see page 766.

DR. GEORGE M. LAWS remarked that his interest in the subject of cortical infections of the kidney began with the publication of Dr. George E. Brewer, who presented the picture of fulminating infections that often demanded immediate life-saving operation. Later, as the condition became better known, it was learned that, in some cases, the infection is comparatively mild, and it was difficult to determine whether early operation was required. The speaker is sure he has seen mild cortical infections clear up entirely without operation and he is still sometimes in doubt as to the treatment to be applied. It is important to remember that there are two types of kidney infection; that the colon bacillus type is manifested by pyelitis or pyelonephritis, and that the coccal type causes cortical lesions, including carbuncle, and complications such as perinephric abscess.

Doctor Laws studied the available cases of perinephric abscess from the standpoint of urinary findings, but as the essayist has said, the findings were often meagre and the study was not fruitful until he learned from various writers of the value of the stained smear in addition to the urine culture. The ordinary culture of the urine does not always give a true bacteriologic report because the cocci may not grow, or may be overgrown, by the colon bacilli.

DR. GEORGE P. MULLER remarked that Doctor Lipshutz had omitted to mention that condition occasionally called Brewer's Kidney or acute unilateral

haematogenous suppurative nephritis. Following Brewer's paper many years ago there were a great many reports of similar cases and as the speaker remembers the cases in his own experience, they were practically the same except for their acuteness as those described by the essayist. In view of the tendency to do conservative procedures upon the kidney, it should not be difficult to do a partial nephrectomy in the chronic type of case mentioned by Doctor Lipshutz instead of complete nephrectomy. That this can be done is shown by one of the case reports from the literature in which a bilateral condition was treated by nephrectomy on one side and nephrotomy on the other. In such cases Doctor Muller would suggest that the wound be unsutured entirely and the cavity filled with gauze in close contact with the infected kidney and perirenal valve.

DR. BENJAMIN LIPSHUTZ, in closing, said that he had attempted to present only the chronic group of cases. Brewer directed attention to the acute cases in which there is a violent clinical picture with evidence of septicæmia and urged immediate surgery. The infections known as chronic carbuncular type persist over a long period of time, lasting not infrequently for months. One of the cases presented symptoms for three months. In the acute type of case the infection is overwhelming. Multiple small abscesses may be associated with the carbuncular type. Some of the cases show multiple carbuncles. In the early stage the carbuncular type is localized and appears from the mildness of symptoms, as a different type of infection, from that observed in acute diffuse haematogenous group. He agreed with Doctor Muller that if the case is subjected to operation at an early stage, conservative surgery consisting of resection of the abscess and packing of the resultant cavity is the desirable procedure. The wound cavity should be left open and free drainage established, otherwise a septic wound may be the result.

CÆCAL DRAINAGE IN ACUTE SUPPURATIVE APPENDICITIS

DR. GEORGE M. DORRANCE remarked that every surgeon can recall numerous instances where a patient after an appendicectomy with drainage was practically moribund but upon developing a faecal fistula promptly began to improve. Abdominal distention with its accompanying discomfort is a frequent and disagreeable complication of suppurative appendiceal cases. These facts led him to believe that in selected cases cæcal drainage should be established after the removal of the appendix.

Regarding indications and contra-indications the essayist said that there is a tendency to drain fewer cases of appendicitis and he is in accord with this view. The cases, however, in which all surgeons agree on drainage are where there is free pus in the abdominal cavity. In his opinion, these should have, in addition to the usual drainage of the peritoneal cavity, cæcal drainage. In cases of localized appendiceal abscess there is a question as to whether or not, in addition to the usual drainage, cæcal drainage is advisable. In these cases, if the appendix has been removed, when the abdomen is opened he employs this procedure. Doctor Dorrance's technic is as follows:

CÆCAL DRAINAGE IN ACUTE SUPPURATIVE APPENDICITIS

After removing the appendix a rubber catheter (Number 20 French) is inserted through the appendiceal stump well into the cæcum and held with a purse-string suture of Number 2 chromic catgut. The cæcum is then allowed to drop back in place and the usual drains are introduced. When the patient is returned to his bed, he is placed in the Fowler position. A small amount of fluid may be immediately introduced by the drip method or any way one wishes. Every three hours the catheter is sucked out with a syringe to remove the fluid intestinal contents, or they are allowed to flow out. The catheter is removed, or comes out of its own accord, in from four to eight days, depending upon the progress of the case.

The advantages are that one secures drainage of the cæcum which prevents post-operative distention. It permits removal of a large amount of liquid faecal material and permits fluid, salt solution, glucose, etc., to be introduced into the colon at a place where absorption can readily occur—an improved Murphy method of getting fluid into these patients. In cases where nature would cause a faecal fistula to develop, the surgeon by establishing cæcal drainage offers a much smaller opening and a stormy convalescence is prevented. It is seldom necessary to do a secondary operation to close the fistula. Secondary hernia do not seem to be more frequent than in drainage cases he has had in the past.

DR. I. S. RAVDIN said that in 1927 Clyde Wilson reported a large number of cases treated by this method with a remarkably low mortality. Since then he has used it a number of times and it seems to have a very definite field of usefulness. He puts the small catheter through the appendiceal stump and uses a long linen suture from the base of the appendix and threads a tube over that so that when the catheter is removed, if any further drainage does occur, there is a ready passage for it. There is no doubt the patient will receive and take much larger quantities of fluid by this method than any other. The speaker does not recall any complications in the cases in which he has used this method.

DR. DAMON B. PFEIFFER said that certainly cæcostomy is unnecessary in the average condition of acute appendicitis. The vast majority of these cases get well without any sort of drainage. The fact that it permits the administration of large amounts of fluid, in itself, would be no indication in most instances. The speaker could think of only one condition in which cæcostomy would be of any value, and that is in a pelvic collection with partial obstruction of the pelvic colon. In that condition it might be very valuable.

DOCTOR DORRANCE, in closing, said that he had observed no disadvantages from the use of this procedure, but has seen many advantages. Fluid can be administered directly into that portion of the bowel from which the maximum absorption takes place. He is sure that distention is less; it decompresses the colon. He uses salt solution and not glucose. He does not advocate the routine employment of cæcostomy, but in bad cases with pus in the peritoneal cavity he does advocate its use. He has had no complications and can see no objections to the method.

BRIEF COMMUNICATIONS

EXTENSIVE RESECTION OF SMALL INTESTINE

FROM a study of the reported cases in which extreme resections of intestine have been performed, it is noted that 220 centimetres (six feet, seven inches) is the limit which can be removed without serious danger of post-operative metabolic disturbances, as indicated by hunger, thirst and diarrhoea.

According to Treves', experience from 100 autopsies the average length of small intestine in the male is 680 centimetres (twenty-two feet, six inches) and in the female nearly fifteen centimetres (six inches) more. This excess, however, might not be confirmed in a larger series. In the male the extremes were 970 centimetres (thirty-one feet, ten inches) and 470 centimetres (fifteen feet, six inches) while in the female they were 890 centimetres (twenty-nine feet, four inches) and 570 centimetres (eighteen feet, ten inches). If these figures be accepted, the removal of 200 centimetres will average about one-third of the total length and may reach near one-half.

The report of results appears to justify resection up to and beyond the usually accepted safety point when necessary as an emergency to save life, but probably does not justify it to remove massive malignancy when the prognosis is essentially poor. According to Brenizer (May, 1929), there have been eighty-three cases of extensive resection of small intestine reported with 85.7 per cent. operative recoveries and 65.5 per cent. showed good functional results.

Metabolic studies show the first effects of the operation is an increase in excretion of the nitrogenous, fatty and carbohydrate elements of the food. However, compensation is usually established. In experimental studies on dogs, Flint reports a compensatory hypertrophy of the remaining portion involving mainly the mucosa and consisting of an increase both in the number and size of the villi, although this has not been found in human cases as yet.

Cathcart suggests that these recoveries may be accounted for by the fact that the small intestine rarely functions to the limit of its capacity but possesses a great reserve power, which will, under favorable dietary conditions, be equal to the larger amount of added work. It is true that there is present in every organ of the body reserve tissue which may be called upon for functional purposes in an exigency. On the other hand, compensation will break down under adverse conditions, such as faulty diet, which could be well borne by normal individuals.

In view of the small number of cases reported and the opportunity of observing the following cases over a considerable period of time they are considered of sufficient importance to report.

DIFFERENTIATION OF BRANCHIAL CYSTS

CASE I.—E. B., white, male, aged twenty-one years, yeoman in Coast Guard, uses alcohol in moderation and smokes pipe occasionally; does not use drugs.

Family history.—Father and mother living and well. Two brothers living and well, none dead. Three sisters living and well, none dead. No history of tuberculosis, cancer, insanity, heart or kidney trouble in family.

Previous personal history.—Has not had any tropical service. Believes he has had all the ordinary childhood diseases and malaria. His right arm was broken when a child. Had gonorrhœa one year ago. No operations. *Chief complaint.*—Pain in right side.

Present history.—States pain came on very suddenly about 9 P. M. May 10, 1929, across lower abdomen and gradually localized in right side. Describes pain as sharp, and cramp-like in character. Nauseated and vomited several times without relief. Bowels not constipated. No increase in urinary frequency or blood in urine. Has never had a similar attack.

Physical examination reveals a fairly well nourished and slightly developed white male lying in bed quietly. Weight, 145 pounds; height, five feet, eleven inches; blood-pressure, 110/70. Examination negative except for marked tenderness and rigidity in right lower quadrant. Rebound tenderness present. Rectum examination negative.

Laboratory findings.—Urine, trace of albumin, granular casts, numerous pus and few blood-cells. Blood count, 30,000 white blood cells with 86 per cent. neutrophiles, 12 per cent. small mononuclear, and 2 per cent. large mononuclears. Wassermann: negative. Coagulation time, five and one-half minutes.

Patient was operated on under ethylene anaesthesia and an acute gangrenous appendix removed. The following day the abdomen was slightly distended but otherwise convalescence was uneventful. On the twentieth day he began to have pain in the abdomen with nausea and vomiting. Blood chemistry, non-protein nitrogen 42.6 milligrams per 100 cubic centimetres and chlorides 445. Diagnosis of intestinal obstruction was made and patient operated under ethylene anaesthesia relieving numerous adhesions and kinking of small bowel, which obliterated the lumen. The patient was in very poor condition and the wound had to be closed as quickly as possible. Convalescence from this operation was also uneventful and the man rapidly regained strength. On the fortieth day following this, however, he had a recurrence of the same symptoms and was again operated upon under spinal anaesthesia with removal of twelve feet of gangrenous small bowel leaving approximately four inches of ileum and eight feet of jejunum. At this time urine was negative, blood showed 4,700,000 red cells, 26,400 white cells with 83 per cent. neutrophiles and 17 per cent. small mononuclears. Hæmoglobin 70 per cent. non-protein nitrogen was twenty-four milligrams per 100 cubic centimetres blood and chlorides 445. Transfusion of 500 cubic centimetres of whole blood was given by direct method.

During convalescence the man complained of occasional attack of diarrhœa which was easily controlled. For two months following operation indican was present in urine and undigested fat and starch in faeces.

After convalescence thirty days' sick leave was granted and on return from this patient was discharged ready for duty. He complained of no digestive disturbance and weighed 140 pounds, undigested fat was still present in faeces.

Six months following operation patient was again seen. He had no complaint and was doing his regular duty. He weighed 145 pounds. Examination was negative except for potential weakness of abdominal wall in operative scar. Urine was negative for indican. Faeces were still positive for undigested fat. This apparently was not affecting his nutrition or general health in any way. At this time X-ray showed barium having reached splenic flexure of the colon in six hours. The small intestine is massed together in the pelvis and freely movable. The colon is practically empty after twenty-four hours. He was again seen eleven months after operation and appeared in good health. At that time he was doing his duty in the Coast Guard and offered no complaint.

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CASE II.—E. W., colored, male, aged forty-one. Occupation, merchant seaman. Occasional use of alcohol and tobacco.

Family history.—Negative. *Previous personal history.*—Has not had any tropical service. Had measles and mumps when a child, no injuries. Had gonorrhœa a few years ago.

Present history.—States that one week ago he was constipated and took several cathartic pills following which he developed pain in lower abdomen, more marked on right side. Was not nauseated and did not vomit. When pain persisted he took several doses of salts without relief. Does not have increased frequency nor blood in urine. Never had similar attack before but has had attacks of indigestion.

Physical examination.—Well-nourished and developed colored male. Weight, 150 pounds; height, five feet, seven inches; blood-pressure, 128/74. Examination negative except for slight rigidity of right lower quadrant and tenderness on deep palpation.

Laboratory findings.—Urine, negative; white blood count, 9,500; Wassermann reaction, 4 plus.

Under ethylene anaesthesia a gangrenous appendix was removed. The appendix was retrocecal and the cæcum was so inflamed and brittle that a portion was removed to make closure. The patient was having an uneventful convalescence when on the tenth day he began to have pain and distension of abdomen with nausea and vomiting. At this time blood showed 8,150 white cells with 77 per cent. neutrophiles, 20 per cent. small mononuclears, 1 per cent. large mononuclears and 2 per cent. transitionals. Non-protein nitrogen was thirty-nine milligrams per 100 cubic centimetres of blood and chloride content 463. There was a palpable mass in the right side of the abdomen. He was again operated upon under ethylene anaesthesia for intestinal obstruction with removal of eight feet of small intestine, cæcum, and four inches of ascending colon. After a hard convalescence he gradually gained weight and had none of the complaints of hunger, thirst and diarrhœa usually associated with large intestine resection. At no time was indican found in the urine. Undigested fat was present in the faeces up to the time of discharge.

When discharged barium enema showed the colon filled without difficulty. The rectum and sigmoid were slightly dilated and the haustra of the sigmoid were not as well defined as they should be. Three months after operation non-protein nitrogen was 31.8 per cent., blood sugar 86.2 per cent. and chloride content 495.

It is interesting to note that extensive resection apparently was not having any effect on blood chemistry in this case.

Ten months after operation he was seen. He offered no complaint, except occasional attack of diarrhœa. He was working as a waiter. He weighed 148 pounds, being well-nourished for his height.

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DIFFERENTIATION OF BRANCHIAL FROM OTHER CERVICAL CYSTS BY X-RAY EXAMINATION

CYSTS in the neck can usually be recognized as such by the ordinary criteria of physical examination. Occasionally, however, they may be confused with inflammatory conditions, especially tuberculous adenitis, and elude identification. Branchial cysts not uncommonly are subject to periodic attacks of inflammation which accounts in large measure for the frequency

DIFFERENTIATION OF BRANCHIAL CYSTS

with which they escape detection. With the almost universally practised procedure of treating tuberculous adenitis with conservative measures, it is important that patients with cysts in the neck be spared the loss of time and disappointment afforded by the treatment accorded patients with tuberculous adenitis.

Two patients have come under my observation in which cervical cysts passed under the guise of other pathologic lesions over a long period of time. One patient was temporized with over a two-year interval under the impression that he had tuberculous adenitis or a "cold abscess" from a tuberculous spondylitis which gave few physical signs. The other patient had been given a diagnosis of tuberculous adenitis and repeated aspirations had been practised when the "abscess threatened to break down."

When the patients were first seen at the University Hospital, the diagnosis of branchial cyst was entertained because of the location of the swelling in each instance. A definite diagnosis, however, could not be made by the usual criteria of physical examination. Following aspiration through a hypodermic needle and the injection of a medium opaque to the X-rays, the diagnosis of cyst was easily made in both instances on X-ray examination. The needle was left *in situ* following the injection and the injected medium was re-aspirated after the inspection of the film.

A much neglected but valuable piece of evidence in the recognition of branchial cysts that has been significantly emphasized by Hamilton Bailey¹ is the presence of cholesterol crystals on microscopic examination of the aspirated content. The high lipid content frequently imparts a shimmer or yellowish sheen to the fluid when it is placed in an open basin. Though not invariably present, these findings are practically conclusive for the existence of a branchial cyst.

X-ray examination with employment of the method suggested here should be of great practical help in all cases of cervical swellings of obscure or indeterminate origin. The finding of a sharply circumscribed limitation of the opaque injection medium on the X-ray film is pathognomonic of a cyst. In the presence of a tuberculous lymph node that had given rise to suppuration or "cold abscess" from a tuberculous spondylitis, the opaque medium would be seen to dissect along the natural tissue planes in an irregular fashion.

Even at operation there may be considerable doubt as to the identity of a branchial cyst. Before employing the procedure described here I have been misled at operation by the presence of considerable lymphoid tissue surrounding the cyst and its universal adhesion to surrounding structures, into believing that I was dealing with a tuberculous lymph node; and in cysts that have been the seat of repeated active inflammation, the information obtained by inspection and microscopic examination of the aspirated content is frequently without special value. A röntgenogram after the injection of an opaque medium, however, gives indubitable evidence as to whether or not a cyst is present.

BRIEF COMMUNICATIONS

REFERENCE

¹ Bailey, Hamilton: *Physical Signs in Clinical Surgery*, p. 34, Wm. Woods and Co., 2d ed. 1930.

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A GUARD FOR THE GIGLI SAW

A SIMPLE DEVICE TO PREVENT THE GIGLI SAW FROM COMING IN CONTACT
WITH ANY OF THE TISSUES EXCEPT THE BONE TO BE CUT

DURING the amputation of a limb, a great deal of time and effort is consumed and unnecessary trauma produced in an attempt to retract the skin, muscle and fascia as high as possible in order to saw off the bone at the desired level. Very often the adjoining tissues are shredded, the retracting towels and drapes are torn, and even the hands of the willing assistant are caught during the to-and-fro motion of the saw. Particularly is this true when dealing with more than one bone such as in an amputation of a leg, in sawing off the metacarpal or tarsal bones or in rib resection. The cramped condition of the parts hinders retraction and free motion of the saw. It was the attempt to deal with such a case that prompted the writer to improvise a simple device to obviate these difficulties.

Recently the writer did a high amputation of the thigh in a very obese woman. This was necessitated because of gangrene extending up to the thigh as the result of an embolus complicating cardiac disease. Following the amputation, a good deal of sloughing of the soft parts ensued because of the poor circulation. The patient, however, survived the operation and six weeks later the wound appeared clean and granulating. As a result of the sloughing, there developed a big cone-shaped cavity about three inches deep with the bone projecting in its depth for about one inch. (Fig. 1-C.) It was deemed advisable to remove the projecting portion of the bone to expedite healing and avoid a painful stump.

The writer was in a quandary as to the method of removing the bone without causing unnecessary trauma to the soft parts, the projecting bone being quite deep in the cavity. Bone cutting forceps would leave ragged edges. It was inaccessible to the ordinary saw because of its depth and it would necessitate undue trauma, additional incisions and forcible retraction of the soft parts in order to gain access to the bone. The Gigli saw was deemed most practical. Even this, however, was not feasible for in order to be able to work the saw at such a depth, one would have to cut down and separate the soft parts to allow for its to-and-fro motion. Whereupon an idea occurred to the writer to use a guard for the saw as presented in the illustration.

The idea was to pass the Gigli saw through a hollow metal tube, the loop of the saw to pass over the stump of the bone to be removed, in a manner similar to the application of the ordinary tonsil snare. The hollow

A GUARD FOR THE GIGLI SAW

tube would act as a guard, retractor and guide and thus prevent injury to the soft parts and enable the saw to be held at any desired level of the bone. A search for a hollow tube however, at this time proved unsuccessful. The writer then spied a Bell stethoscope which was being used for blood-pressure in spinal anæsthesia. This appeared to be most ideal for the purpose as it fulfilled all the requirements. It has a wide bell-like opening at one end and

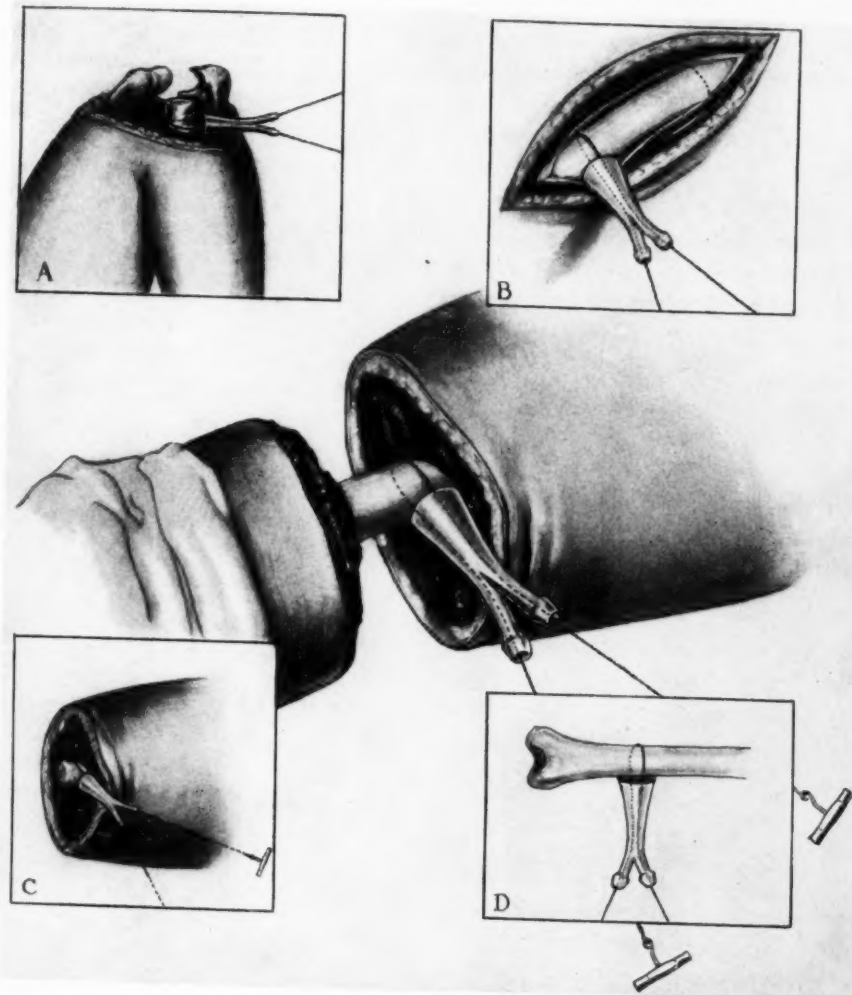


FIG. 1.—Guard for the Gigli saw. Amputation at middle of thigh. Bone to be sawed off with Gigli saw, using bell of stethoscope as a guard. Note the ease with which loop of saw can be placed at any level of the bone with the aid of this guard. A.—Excision of head of radius. B.—Resection of rib. C.—Secondary removal of stump of femur. All with aid of guard which makes retraction of soft parts unnecessary. D.—Note close contact of guard held against bone which serves to steady bone during the sawing motion.

two Y branches at the other end through which the Gigli saw could readily be threaded and serve the purpose above described.

The projecting bone was thus removed in less than a minute with no more than twenty motions of the saw. The writer was greatly surprised at

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the rapidity, ease and exactness with which the bone was sawed off with the aid of this improvised guard for the Gigli saw. By holding the guard firmly against the bone it was steadied and the disconcerting to-and-fro motion of the stump ordinarily produced by the pulling of the saw was avoided. By referring to the illustration, one can readily see the practicability and usefulness of a hollow metal tube for this purpose. A modification of this guard as to shape and size may prove of value, depending upon the location, size and thickness of the bone to be dealt with. Naturally in sawing off a very thick bone, a wider and more flattened tube may be advantageous, while working in a narrow space such as resection of rib or mandible, a smaller tube of a somewhat different shape may be useful. The principle however, is the same in all cases, namely, to utilize a hollow tube for the purpose.

The tube helps to steady the bone, guide the saw, retract the soft parts and guard them from being injured. It thus greatly enhances the usefulness of the saw, enables one to sever almost any bone without fear of direct injury to surrounding parts, eliminates unnecessary and forcible retraction of the adjoining structures with its incident devitalization, and it makes the work of the surgeon and his assistants less arduous and more effective. A single attempt will readily convince the surgeon of the usefulness and practicability of the writer's guard for the Gigli saw.

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A METHOD FOR MAKING A SATISFACTORY FISTULA AT ANY LEVEL OF THE GASTRO-INTESTINAL TRACT*

It is well known that it is difficult to maintain in a normal physiologic condition animals in which a fistula has been established in any portion of the gastro-intestinal tract. The difficulties are mainly those associated with loss of the contents of the part of the tract in which the fistula was produced, with the resulting decrease in nutrition and possible excoriation around the stoma. The seriousness of these complicating factors depends on the portion of the digestive tract from which the contents are lost. Contents lost from the lower portion of the digestive tract, as from the lower portion of the ileum and colon, is usually not serious, although decrease in weight associated with some injury to the surface of the skin around the fistulous opening does occur. However, loss of secretion from the upper part of the digestive tract, as the stomach, jejunum, or upper portion of the ileum, usually proves rapidly fatal.^{1, 2, 3} or productive of marked and rapid decrease in the nutrition of the animal associated with considerable injury to the surface of the skin by the discharged digestive juices. In any event, animals from which any considerable amount of gastro-intestinal contents are being lost are not altogether suitable subjects for physiologic study.

In some of our investigations it was necessary to obtain specimens of the contents of the gastro-intestinal tract at various levels repeatedly over

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GASTRO-INTESTINAL TRACT FISTULA

long periods of time. After various methods had been tried, the following procedure was devised and has proved satisfactory to us. Essentially the method consists in isolating a short loop of the terminal portion of the ileum and employing it to make the fistulous tract to the portion of the gastro-intestinal tract in which it is desired to tap.

All operative procedures are performed under ether anaesthesia with the employment of surgical technic. The abdominal cavity is entered through a low median-line incision, and the terminal portion of the ileum is exposed. This portion of the intestine is easily recognized by the longitudinal artery

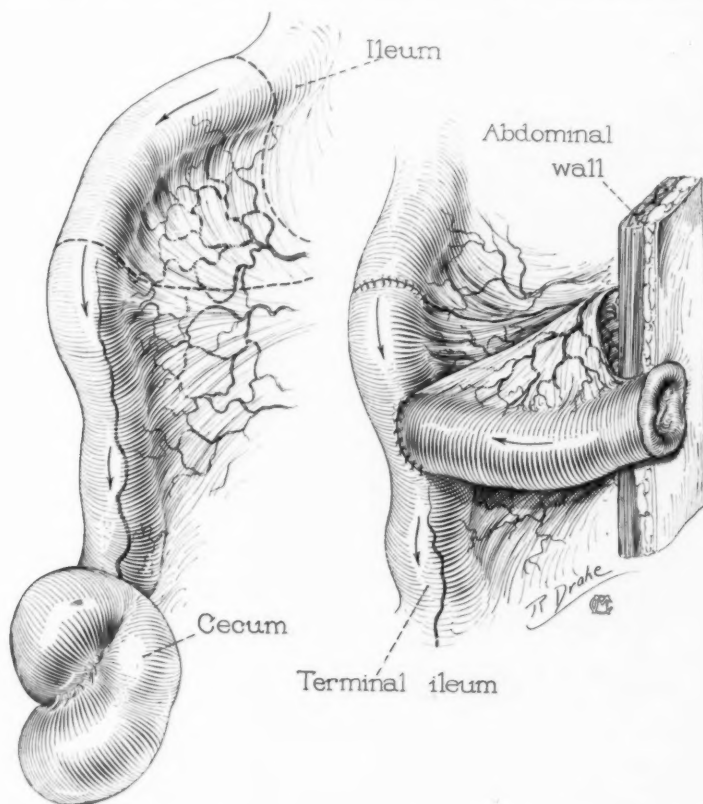


FIG. 1.—The essential steps in the procedure. The fistula was in the terminal portion of the ileum. It is readily seen that the same procedure can be used for any other portion of the gastro-intestinal tract.

coursing on its wall so prominently in the dog. The first loop of ileum cephalic to the termination of the longitudinal artery is carefully isolated. This loop should be from 15 to 20 centimetres in length and should have a long mesentery. Before the lumen of the intestine is opened the portion of the digestive tract in which the fistula is desired should also be exposed. Both sites of operation should be carefully packed off. The isolated loop is clamped at each end, and the intestine is severed so that the clamps are left on the ends of the isolated loop. The continuity of the intestine is reëstab-

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lished with either end-to-end or side-to-side anastomosis. The isolated loop is then gently transferred, without stretching its mesentery, to the other exposed section of the digestive tract. End-to-side anastomosis is done between the distal end of the transposed loop of ileum and the other exposed area of the digestive tract at the exact site at which the fistula is desired. The free end of the transposed loop is then drawn through a stab wound, and sutured to the skin (Fig. 1).

This procedure makes it possible to have a fistulous tract lined with mucosa from the surface of the body to any portion of the gastro-intestinal



FIG. 2.—Double fistula. The lower opening leads into the pyloric region of the stomach and the upper opening leads into the duodenum. Each loop was anastomosed about 2 centimetres from the pyloric sphincter on its respective sides. Hundreds of samples of gastric and duodenal contents were secured from these fistulas. The perfect condition of the mucosa and adjacent skin surface may be noted. These fistulas have been under observation for more than twenty months.

gastro-intestinal tract, in excellent condition for several years. It is also possible to tap the gastro-intestinal tract at two or more points, that is, to make a fistula of the stomach and of the duodenum, or any portion of the lower part of the intestine (Fig. 2).

There are a few points in technic that we have found worthy of consideration. It is essential, as in most gastro-intestinal operations on the dog, to be careful to pack off all the sites of operation on the tract before the lumen of the intestine is opened and soiling from gastro-intestinal contents is per-

tract. Since the waves of peristalsis in the transposed loop pass from the surface of the skin to the lumen of the tract, leakage does not often occur. The passage of a suitable catheter through the transposed loop into the lumen of the digestive tract permits both the withdrawal of specimens of the gastro-intestinal contents and the injection of food and other substances. It has been found possible to secure from sixty to one hundred samples of intestinal contents through such a fistula, or to maintain a continuous flow by allowing the catheter to remain in place during the course of ten hours without having any serious leakage occur. We have found it possible to maintain animals, with fistulas at various portions of the

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mitted. Care should be taken in the end-to-side anastomosis to make a large opening, as the only difficulty so far encountered has been gradual stenosis at the site of this anastomosis. We have also found it advantageous to use fine catgut for this particular anastomosis. It is obvious that a loop of the jejunum or upper portion of the ileum could also be transposed. However, the loop from the terminal portion of the ileum suits the purpose better.

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BOOK REVIEWS

OPERATIVE GYNECOLOGY. By HARRY S. CROSSEN, M.D., and ROBERT J. CROSSEN, M.D. Fourth edition, 8vo.; cloth; pp. 1054. C. V. Mosby Company, St. Louis, 1930.

This, the fourth edition of Doctors Crossen's "Operative Gynecology" shows the usual attention to detail characteristic of the authors—even the preface is valuable and instructive. By giving credit where credit is due they have really internationalized their book. This is well exemplified in the chapter which includes vesico-vaginal fistulae. The work has been amplified to twenty-four chapters. The teaching value of the work is greatly enhanced by the profusion of the excellently executed illustrations. It is evidently the production of men who have thought as they have worked. Their consideration of the development of the proper procedure gives an authoritative atmosphere to that which they recommend and practise. Their finality and deductions are convincing and their attitude is wholesome.

The psychological effect upon the reader of their reporting their fatal cases is of great value to everyone. Their illustrative cases in the text are very instructive. Those of us who have been unfortunate enough to injure a ureter during the performance of a hysterectomy have all gone through the stage of identification of the ureter by the introduction of ureteral catheters pre-operative.

The authors' consideration of mooted points throughout the book relieves the reviewer of any criticisms against their regard for detail. The only real criticism is the use of proctoclysis, post-operatively, in cases of ectopic gestation.

In chapter XIV on the external genitals and vagina they have included the lymphatics of the vulva, the review of which, including those of the whole pelvis, from an anatomical standpoint is of great help not only in the consideration of malignancy but also for any infectious process. Regarding malignancy of the external genitals, the Doctors Crossen have produced a remarkably clear set of ideas, especially from the standpoint of classification. Chapter XV on disturbances of function necessitates being familiar with their book on "Diseases of Women."

The inclusion of chapters on appendectomy, the intestinal tract and hernia show the finished gynæco-abdominal surgeons. The attitude on femoral hernia is especially to be recommended.

ALBERT M. JUDD.

PIERSOL'S HUMAN ANATOMY. 9th Ed. Revised under supervision of G. Carl Huber, M.D., Sc.D. J. B. Lippincott Co. 1930.

During the last two decades there have appeared numerous articles extolling the new "physiological surgery" as opposed to the former "anatomical

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surgery." This has led some, particularly those who have been medical students during this period, not only to emphasize physiology, which of course is highly commendable, but also to belittle the importance of anatomy. Medical schools have been forced to shorten the course in anatomy from two years to one, principally because of the vast amount of new knowledge to be imparted in all the other departments, rather than because of any lessened importance of anatomy itself. Although we feel that, in general, medical education has greatly progressed during this period and that students are better fitted to handle themselves, still it does seem that the anatomical foundation is not quite so strong among recent graduates as formerly. This situation is particularly evident in surgery; for although no one will deny the importance of physiology, still both physiology and surgery must be based on a fundamental knowledge of anatomy.

For this reason the appearance of the new ninth edition of Piersol's *Human Anatomy* is of significance, and it is to be hoped that it may stimulate added interest in this important subject. From the first edition in 1907 through the eighth edition in 1923, Doctor Piersol carried the tremendous load of editorship of this huge volume, aided, in the writing of the text, by Drs. Thomas Dwight, Carl A. Hamann, J. Playfair McMunich, and J. William White. The editorial work of this monumental text-book has now been intrusted to Dr. G. Carl Huber, under whose efforts the ninth revision now appears. Doctor Huber has been assisted by members of the staff of the Department of Anatomy of the University of Michigan, and, particularly in the revision of the "Practical Considerations," by Dr. Eldridge L. Eliason, Professor of Clinical Surgery of the School of Medicine of the University of Pennsylvania.

Descriptive gross anatomy shows but little change between editions, so that revision of subject-matter has been confined largely to the sections dealing with histogenesis of the lymphatics and primary veins, the peripheral nervous system, and the fibre-paths of the central nervous system. The main editorial revision has been the more complete introduction into the text of the Basle anatomical nomenclature. Fortunately for those who were brought up on the less-consistent English terminology both appear throughout. This more complete use of the Basle system in one of America's outstanding anatomical text-books is evidence of the progress the Basle Congress has made since 1907. In the original preface Doctor Piersol said:

The constant aim of the editor has been to use the simplest anatomical terminology, and preference has always been given to Anglicized names, rather than to the more formal designations. Although in many cases the modifications suggested by the new terminology have been followed with advantage, consistent use of the Basle nomenclature seems less in accord with the conceded directness of English scientific literature than the enthusiastic advocates of such have demonstrated.

This acceptance today of the international anatomical terminology seems but another indication that the world, with communication improving in

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every way, is becoming more closely knit. The pagination of the eighth edition has also been maintained, so that guides and outlines based on the last edition may still be used without change.

The general appearance of the new edition is entirely unchanged. There are 2,104 pages, with 1,734 illustrations, 1,522 of which have been selected from more than 2,000 original drawings made largely from the dissections of Dr. John C. Heisler. Those who are familiar with these fine illustrations know that it has been the editor's aim to present the actual appearance of parts rather than to schematize them.

In this edition most of the line-drawing diagrams of the central and sympathetic nervous system tracts have been redrawn, corrected, and extended to comply with the textual revision. A new colored plate showing the development of the reticulo-endothelial cell or histocyte, in bone marrow, has been inserted to illustrate the new description of "The Development of the Corpuscular Elements of the Blood." The monophyletic theory, that all the blood cells, both red and white, are derived from a common mother cell, is very briefly outlined, Marimow's work being particularly alluded to.

Unlike descriptive gross anatomy, which is now fairly standardized, "Practical Suggestions" require constant revision, because of the continuous rapid advances in surgery. Doctor Eliason has been responsible for this part of the work and has revised, and in places added to the "Suggestions." It is readily understandable that with pagination fixed and sections of space limited to former allotments, extensive changes are almost impossible. These "Suggestions," however, are very important, probably most so because of the interest they add to the pabulum which most medical students consider only too dry.

In closing it is entirely unnecessary to add any recommendation of this pre-eminent volume to the reader, who already undoubtedly knows it as an old friend. Doctor Huber and his staff, however, certainly deserve the thanks of the entire profession for the tremendous amount of time and energy required in editing this new edition.

WILLIAM H. FIELD

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